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(54) **ROTARY SEALING SYSTEM**

ROTIERENDES VERBINDUNGSSYSTEM

APPAREIL DE SOUDAGE ROTATIF

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Description

[0001] This invention relates to apparatus and methods for applying thermal energy to workpieces, such as for bonding, sealing, cutting and the like of the workpieces. More particularly, the present invention relates to an apparatus and method for applying ultrasonic energy to workpieces such as disposable diapers, training pants, feminine care products, feminine care and incontinence garments or the like.

[0002] Use of mechanical vibration produced at an ultrasonic frequency to weld thermoplastics, and to emboss and form plastics is a well-established industrial process. The physical principles underlying this technology have important relations to the invention described herein and therefore merit brief review and discussion.

[0003] To obtain significant vibrational motion, most ultrasonic systems are operated at one of their frequencies of resonance. Both the ultrasonic generator and the ultrasonic horn are designed to resonate at the same frequency, in which case the vibration produced by the generator is communicated to the horn. Since the horn is tuned to the same frequency as the generator, the horn expands and contracts along its length in concert with the imposed motion of the vibration generator.

[0004] The motion produced at the free face of the horn is then reciprocal, or back and forth in a surface perpendicular to the surface of the horn, with an amplitude determined by the electrical voltage applied to the crystals of the vibration generator. It is known to condition the vibrations produced by the generator before the vibrations are communicated to the horn, including incorporating amplification devices and phase change devices into the sequence of elements so used.

[0005] One problem encountered in applying resonant ultrasonic vibration to continuous processes is the limitation on horn width. Although the horn executes motion principally of contraction and extension along its working surface, the wider the horn, e.g. the longer its working surface, typically the greater the variation in the amplitude of the vibrations along the length of the working surface. Accordingly, in general, use of ultrasonic energy to process workpieces in a continuous web has been limited to two types of processes.

[0006] The first type of process is one where a rotary ultrasonic horn disposed in a fixed location applies ultrasonic energy, against an underlying anvil, at essentially a line along a workpiece travelling, in a longitudinal direction along the workpiece, past the rotating horn. This first type of process is illustrated by United States Patent 3,222,235 to Buchner.

[0007] The second type of process is one where one or more stationary flat planar surface or plunge-type, as they are commonly referred to, ultrasonic horns extend across the width of the web and apply ultrasonic energy to all or selected parts of the web as the web passes between the stationary horns and corresponding underlying anvils, as illustrated by United States Patents 3,939,033 to Grgach et al and 3,733,238 to Long et al, respectively. The plunge-type may imply its motion, however, the horn may, in fact, be stationary and the web moved to it.

[0008] In a first modification of the second type of process, United States Patent 4,713,132 to Abel et al teaches mounting a series of flat planar surface horns for rotation about fixed axes disposed'about a rotating anvil drum, and rotating the horns such that the horns rotate into and out of contact with the workpieces on the web.

[0009] In a second modification of the second type of process, United States Patent 4,650,530 to Mahoney et al teaches folding the web of workpieces about the periphery of a rotating disc, and bringing ultrasonic horns, and corresponding anvils into alignment with the workpieces, as they rotate on the disc. The horns and anvils are of the flat planar surface arrangement. The horns and anvils rotate with the disc, and the ultrasonic system operates on the workpieces by bringing respective sets of horn and anvil against the respective workpiece at a locus in a free space between radially extending protrusions on the disc. Thus the disc which carries the workpieces does not participate in the application of ultrasonic energy, and the reciprocating motion of the ultrasonic horns operates in a direction coincident with the direction of extension of the axis of the rotating disc which carries the workpieces.

[0010] A second problem with flat planar surface ultrasonic horns is that, in order to obtain uniform application of the ultrasonic energy along the length of the horn, the spacing of the horn from the anvil must be aligned in two dimensions along the face of the horn such that the working surface of the horn is e.g. precisely parallel with the working surface of the anvil. Especially where there is e.g. any continuing motion of the horn or the anvil other than the ultrasonic vibrations, for example rotation of either or both of the horn or anvil, such precise alignment becomes a dynamic problem, requiring constant monitoring and repeated adjustment of the spacing between the horn and the anvil.

[0011] In EP 0 251 070 an apparatus and a method for ultrasonically bonding a material is disclosed. The herein disclosed apparatus comprises bonders having respective anvil and sonotrode components which are synchronously orbited with each other and with the rotation of a rotatable drum which carries the web of material to be bonded. One of the anvil and sonotrode components is orbited exteriorly of the drum and the other interiorly of the drum and they are brought into facing alignment through openings in the drum to clamp segments of the material therebetween during passage through a bonding segment of the travel path of the web about the drum. The apparatus and the method are disadvantageous in that the sonotrodes have to be aligned precisely with the respective anvils to obtain a uniform application of the ultrasonic energy.

[0012] The present invention intends to overcome

these problems. The object is solved by the -energy system according to independent claim 1 and further by the method of independent claim 26.

[0013] Further advantages, features, aspects and details of the invention are evident from the dependent claims, the description and the accompanying drawings. The claims are intended to be understood as a first, non-limiting approach to defining the invention in general terms.

[0014] It is one aspect of this invention to provide an ultrasonic system including an ultrasonic horn and a co-operating anvil wherein one of the horn and anvil is mounted on a rotating web-carrying work drum, and the other of the horn and anvil is mounted for rotation with the work drum, and to extend over the work drum to apply ultrasonic energy to a workpiece and to withdraw from over the work drum during each rotation of the work drum.

[0015] It is another aspect to provide an ultrasonic system wherein the anvil is mounted on the work drum and the ultrasonic horn is mounted for rotation with the work drum, and for extending over the work drum and withdrawing from over the work drum during each rotation of the work drum.

[0016] It is still another aspect to provide an ultrasonic system wherein the horn is a rotary ultrasonic horn adapted to traverse across the width of the workpiece web, applying pressure and ultrasonic energy, thus to provide line application of ultrasonic energy to the workpiece, moving progressively across the workpiece on the web.

[0017] According to still another aspect of the invention, a system is provided including a plurality of sets of horns and anvils disposed about the circumference of the work drum, wherein the system can simultaneously process a related plurality of workpieces.

[0018] Yet another aspect is to provide an ultrasonic system wherein one or more ultrasonic horns of the plunge type are mounted on the rotating work drum, and a corresponding anvil is mounted for rotation with the work drum, and for extending over the work drum and withdrawing from over the work drum during each rotation of the work drum.

[0019] A further aspect is to provide an ultrasonic system wherein one or more ultrasonic horns of the plunge type are mounted on the rotating work drum and the respective anvil is a rotating anvil adapted to traverse across the width of the workpiece web applying pressure against the respective horn, thus to provide line application of ultrasonic energy to the workpiece, moving progressively across the web.

[0020] This invention describes a thermal energy system for applying ultrasonic energy to a workpiece, the system comprising a drum, mounted for rotation about a first axis in a given direction, the drum having a circumferential outer working surface; a first ultrasonic application device, mounted on the drum at the outer working surface, and extending transverse to the direction of rotation of the drum; and a second ultrasonic application device, mounted for rotation with the drum, and for moving in a direction transverse to the direction of rotation of the drum to thereby extend over the first ultrasonic application device, and operate in combination with the first ultrasonic application device, to apply ultrasonic energy to the workpiece during rotation of the drum, and for subsequently withdrawing from over the first ultrasonic application device during rotation of the drum, one of the first and second ultrasonic application devices comprising an ultrasonic horn adapted to provide ultrasonic energy, the other of the ultrasonic application devices comprising an anvil adapted to cooperate with the ultrasonic horn.

[0021] In a first family of embodiments of the ultrasonic system, the first ultrasonic application device comprises the anvil, and the second ultrasonic application device comprises the ultrasonic horn. The anvil may comprise a metal bar mounted flush with the outer working surface of the drum.

[0022] The ultrasonic horn is preferably mounted to extend over the anvil, to apply downward pressure on a workpiece on the anvil, thereby to apply ultrasonic energy to the workpiece while being extended over the anvil, and to subsequently withdraw from over the anvil, during each 360 degree rotation of the drum.

[0023] The ultrasonic horn may be mounted to traverse an energy application path over the anvil and a workpiece on the anvil, the energy application path extending transversely across the outer working surface, the ultrasonic system preferably further comprising means for simultaneously applying pressure and ultrasonic energy through the ultrasonic horn, to the workpiece disposed on the anvil, thereby to accomplish work on the workpiece while the ultrasonic horn is so traversing the energy application path.

[0024] In preferred ones of this first family of embodiments, the ultrasonic horn comprises a wheel, thus a rotary ultrasonic horn, mounted for rotation about a second axis, to thereby apply ultrasonic energy to the workpiece at a point progressively moving across the workpiece as the ultrasonic horn traverses the energy application path. The energy application path may include an outgoing segment wherein the rotary ultrasonic horn is extended over the anvil and an incoming segment wherein the rotary ultrasonic horn is withdrawn from over the anvil, the ultrasonic system further comprising means for applying pressure through the rotary ultrasonic horn to the workpiece as the ultrasonic horn traverses the energy application path, and control means adapted to activate the means for applying pressure, to thereby apply pressure through the rotary ultrasonic horn to the workpiece on one of the segments of the energy application path, preferably the outgoing segment, and to withhold the pressure on the other of the segments of the energy application path.

[0025] Also in preferred ones of this first family of embodiments, the ultrasonic system comprises at least

two, or more, of the anvils mounted essentially at different radial locations about the outer working surface of the drum, and corresponding at least two of the ultrasonic horns, preferably rotary ultrasonic horns, mounted for rotation with the drum and over respective ones of the at least two anvils, the control means including means for controlling operation of all of the at least two ultrasonic horns such that the respective ultrasonic horn begins being extended over a respective one of the anvils when the respective anvil is disposed at a locus corresponding to a first angle "E" measured with respect to a reference line passing through the first axis of rotation and subsequently withdraws from over the respective said anvil such that said rotary ultrasonic horn is fully withdrawn from over the respective anvil when the drum has rotated such that the respective anvil is disposed at a locus corresponding to a second angle "W" measured with respect to the reference line passing through the first axis of rotation, and wherein the same angles "E" and "W" apply for each of the at least two ultrasonic horns.

[0026] In a second family of embodiments of the ultrasonic system, the first ultrasonic application device comprises the ultrasonic horn, and the second ultrasonic application device comprises the anvil. In this second family of embodiments, the ultrasonic horn typically comprises a plunge-type ultrasonic horn, having an ultrasonic working surface mounted essentially flush with the outer working surface of the drum.

[0027] The anvil is mounted to extend over the ultrasonic horn, to apply pressure on a workpiece on the ultrasonic horn, and thereby to apply ultrasonic energy to the workpiece while being extended over the ultrasonic horn, and accomplish work on the workpiece while so traversing the ultrasonic horn, and to subsequently withdraw from over the ultrasonic horn, during each 360 degree rotation of the drum.

[0028] In preferred embodiments, the anvil comprises a wheel mounted for rotation about a second axis, thus a rotary anvil, such that the combination of the anvil and the ultrasonic horn provides effective ultrasonic energy to the workpiece at a line moving progressively across the workpiece as the anvil traverses the energy application path. The energy application path may include an outgoing segment wherein the rotary anvil is being extended over the ultrasonic horn and an incoming segment wherein the anvil is withdrawn from over the ultrasonic horn, the ultrasonic system further comprising means for applying pressure through the rotary anvil to the workpiece as the workpiece traverses the energy application path, and control means adapted to activate the means for applying pressure, to thereby apply pressure through the rotary anvil to the workpiece on one of the segments, preferably the outgoing segment, of the energy application path and to withhold the pressure on the other of the segments of the energy application path.

[0029] The ultrasonic system may further comprise at least two ultrasonic horns mounted at different radial locations about the outer working surface of the drum, and corresponding at least two anvils, preferably rotary anvils, mounted for rotation with the drum and over respective ones of the at least two ultrasonic horns, the control means including means for controlling operation of all of the at least two anvils such that the respective anvil begins being extended over a respective ultrasonic horn when the respective anvil is disposed at a locus corresponding to a first angle "E" measured with respect to a reference line passing through the first axis of rotation and subsequently withdraws from over the respective anvil such that the rotary ultrasonic horn is fully withdrawn from over the respective ultrasonic horn when the drum has rotated such that the respective ultrasonic horn is disposed at a second angle "W" measured with respect to the reference line passing through the first axis of rotation, and wherein the same angles "E" and "W" apply for each of the at least two ultrasonic horns.

[0030] In a third family of embodiments of the ultrasonic system of the invention, the system further comprises placing means adjacent the drum, at a placing station disposed at an angle "P" measured with respect to a reference line passing through the first axis, for placing a workpiece onto a working station of the outer working surface where ultrasonic energy can be applied to the workpiece by the first and second ultrasonic application devices; removing means adjacent the drum, at a removing station disposed at an angle "R" measured with respect to the reference line passing through the first axis, for removing the workpiece from the outer working surface, such that the workpiece traverses a working path on the outer working surface essentially about the circumference of the drum from the placing station to the removing station; and control means for controlling movement of the second ultrasonic application device such that the second ultrasonic application device extends over the drum and correspondingly over the first ultrasonic application device and the workpiece while the workpiece traverses the working path and withdraws from over the drum and the first ultrasonic application device while the working station of the outer working surface traverses from the removing station to the placing station.

[0031] In a fourth family of embodiments, the invention comprehends a method comprising the steps of rotating a drum about a first axis in a given direction, the drum having a circumferential outer working surface, a first ultrasonic application device mounted on the drum at the outer working surface and extending transverse to the direction of rotation of the drum; providing a second ultrasonic application device, mounted for rotation with the drum; moving the second ultrasonic application device in a direction transverse to the direction of rotation of the drum and thereby extending the second ultrasonic application device over the first ultrasonic application device and operating the first and second ultrasonic application devices in combination and thereby applying ultrasonic energy to the workpiece during ro-

tation of the drum; and withdrawing the second ultrasonic application device from over the first ultrasonic application device during rotation of the drum, one of the first and second ultrasonic application devices comprising an ultrasonic horn adapted to provide ultrasonic energy, the other of the ultrasonic application devices comprising an anvil adapted to cooperate with the ultrasonic horn.

[0032] The method preferably includes extending the second ultrasonic application device over the first ultrasonic application device, applying pressure on a workpiece on the first ultrasonic application device, and thereby applying ultrasonic energy to the workpiece, and accomplishing work on the workpiece while the second ultrasonic application device is so traversing the energy application path, and subsequently withdrawing the second ultrasonic application device from over the first ultrasonic application device, during each 360 degree rotation of the drum.

[0033] The first ultrasonic application device may comprise an anvil, with the second ultrasonic application device comprising a rotary ultrasonic horn, e.g. a wheel, mounted for rotation about a second axis, namely a rotary anvil, with the method comprising applying ultrasonic energy to the workpiece at a line moving progressively across the workpiece as the second ultrasonic application device traverses the energy application path.

[0034] Preferably, the method comprehends applying pressure, through the second ultrasonic application device to the workpiece as the second ultrasonic application device traverses the energy application path. The energy application path permissively includes an outgoing segment wherein the second ultrasonic application device, e.g. a rotary ultrasonic horn, is extended over the first ultrasonic application device and an incoming segment wherein the second ultrasonic application device is withdrawn from over the first ultrasonic application device, whereupon the method may further comprise controlling the second ultrasonic application device and thereby applying pressure through the second ultrasonic application device to the workpiece on one of the segments of the energy application path, preferably the outgoing segment, and withholding the pressure on the other of the segments of the energy application path.

[0035] The method permissively operates in an ultrasonic system comprising at least two first ultrasonic application devices mounted at different radial locations about the outer working surface of the drum, and corresponding at least two second ultrasonic application devices mounted for rotation with the drum and over respective ones of the at least two first ultrasonic application devices, and including controlling operation of all of the at least two second ultrasonic application devices and thereby beginning to extend each second ultrasonic application device over a respective first ultrasonic application device when the respective first ultrasonic application device is disposed at a locus corresponding to a first angle "E" measured with respect to a reference line passing through the first axis of rotation, rotating the drum, and subsequently withdrawing the respective second ultrasonic application device from over the respective first ultrasonic application device such that the second ultrasonic application device is fully withdrawn from over the first ultrasonic application device when the drum has rotated such that the respective first ultrasonic application device is disposed at a second angle "W" measured with respect to the reference line passing through the first axis of rotation, and wherein the same angles "E" and "W" measured with respect to the reference line passing through the first axis of rotation, apply for each of the at least two second ultrasonic application devices.

[0036] The method may include placing a workpiece onto a working station of the outer working surface at an angle "P" measured with respect to a reference line passing through the first axis; rotating the drum; while rotating the drum, controlling movement of the second ultrasonic application device and thereby extending the second ultrasonic application device over the drum and correspondingly over the workpiece; and withdrawing the second ultrasonic application device from over the drum such that the second ultrasonic application device is withdrawn from over the drum while the working station of the outer working surface traverses from the removing station to the placing station.

[0037] The present invention will be more fully understood and further advantages will become apparent when reference is made to the following detailed description of the illustrated embodiments and the accompanying drawings, in which:

Fig. 1 is a perspective view of a workpiece which may be made using methods and apparatus of this invention.

Fig. 2 is a top view of a finished workpiece blank, as a workpiece in a continuous web, from which the workpiece of Fig. 1 can be made.

Fig. 3 is a pictorial view, with parts missing and parts cut away, showing a thermal energy system of the invention.

Fig. 4 is a cross-section of the thermal energy system of Fig. 3, taken at planar section 4-4 of Fig. 3.

Fig. 5 is a schematic representation of an end elevation view of the thermal energy system of Fig. 3.

Fig. 6 is a top view of first and second thermal energy application device, taken at 6-6 of Fig. 3.

Fig. 7 is a side view of the second thermal energy application device of Fig. 6.

Fig. 8 is a cross-section as in Fig. 4, of a second

embodiment of thermal energy systems of the invention.

[0038] The following detailed description of the illustrated embodiments is made in the context of making disposable type garments such as diapers, training pants, feminine care products, incontinence garments, and the like, and includes apparatus and methods for joining two superposed spunbonded polypropylene elasticized composite webs, e.g. 23.74 g per m^2 (0.7 ounce per square yard) each, by producing ultrasonic welds at spaced locations extending across the webs in directions transverse (cross machine direction) to the direction of travel of the webs in the processing apparatus (with machine direction). The specific context is the production of disposable type garments in a continuous combined web, where the garment preforms in the web extend transverse to the web, with the waist portions of the garments extending along the machine direction of the web, and the front and back portions of the garments being on opposing sides of the web. In the embodiments illustrated, the welds join the superposed webs at locations generally corresponding to the ultimate locations of side seams in the finished garments.

[0039] It is generally known to make a garment 10 of the type shown in Fig. 1. Such garments typically comprise an assemblage of two or more layers or partial layers of different materials or may comprise substantially the same materials, along with other elements. Typically, the material is a woven or non-woven fabric, or a polymer film. Elastic may be used at the waist 12, in the body portion 14, and around the leg openings 16.

[0040] In this context, as in most such processes for fabricating the garment as at 10, a blank 18 such as that shown in Fig. 2 is first made as part of a continuously processed composite web of materials. After the blank 18 is fully fabricated, the sideseams 20 are formed and the garment 10 is severed from the web either as a blank 18, fully finished or partially finished, or as a fully formed garment article.

[0041] The process contemplated by the invention forms the welds 22 adjacent the adjoining edges of leading and trailing blanks 18A and 18B as illustrated in Fig. 2. In forming such transverse welds 22 using known technology, it is difficult to obtain uniform application of thermal energy across the entire width of the web, whereby the welds 22 may exhibit less than the desired uniformity. The apparatus and methods disclosed hereinafter provide a novel approach to achieving predictably uniform such welds 22 in the blanks 18 being formed.

[0042] Figs. 3-7 illustrate one embodiment of a thermal system of the invention. said thermal energy system may be comprised of any device by which the transfer of thermal energy is sufficient to weld the material together, such as electrical resistance devices such as continuously heated or intermittently heated impulse type devices, or induction heated components. The preferable thermal energy source is by the use of ultrasonics. As seen there, an ultrasonic system 24 includes a work drum 26 mounted on an outer shaft 25, for rotation about an axis 28 passing through a fixed inner shaft generally designated as 30. The work drum 26 has an outer working surface 32 perforated and otherwise adapted in conventional manner (not shown) to provide suction through the outer working surface of the work drum 26, to hold a web 33 of material workpieces which, when all processing is finished, can be assembled as blanks 18 into the garment articles 10.

[0043] A plurality of anvil bars 34 (six are shown) are mounted to the work drum 26, spaced uniformly about the outer circumference of the work drum 26, and extend transversely across the width dimension of the outer working surface 32 of the work drum 26. The anvil bars 34 are flush with the outer working surface 32, such that outer surfaces 36 of the anvil bars 34 generally comprise a continuation of the outer working surface 32 of the work drum 26.

[0044] A support drum 38 is secured to the work drum 26, and mounted for rotation with the work drum. Referring to Fig. 4, support drum 38 is secured to work drum 26 at interface wall 40. The combination of the work drum 26 and the support drum 38 are mounted to the outer shaft 25. Outer shaft 25 is mounted to the fixed inner shaft 30 by bearings 42 and 44. An outer wall 46 of the support drum 38 is secured to end flange 48 through end wall 49. End flange 48 is secured to driven shaft 50 which is driven off the line shaft, not shown, of the processing line. Driven shaft 50 is mounted to ground through bearing 52. Accordingly, the work drum 26, the support drum 38, and the end flange 48 are all supported by the combination of bearings 42, 44, and 52, and all rotate in unison about fixed inner shaft 30 and the axis 28.

[0045] Cam drum 54 is fixedly secured to fixed inner shaft 30, such that it does not rotate with the combination of work drum 26, support drum 38, and end flange 48. Cam rib 56 is mounted on the outer wall 58 of the cam drum 54, and extends about the entire circumference of the outer wall 58 of the cam drum 54. Cam rib 56 is seen in dashed outline in Fig.S 4 and 8. A portion of the cam rib 56 is seen through a cutaway portion of the outer wall 46 of the support drum in Fig. 3.

[0046] Six pairs of carriage support tracks 60 are secured to the outer wall 58 of cam drum 54, corresponding in number, and in general location, to respective anvil bars 34 on the outer working surface 32 of work drum 26. A carriage 62 is mounted to each pair of carriage support tracks 60, for sliding engagement with the carriage support tracks 60, along the lengths "L" of the respective carriage support tracks 60, as will be illustrated further hereinafter.

[0047] Referring now to Figs. 6 and 7, an ultrasonic support subassembly 64 is mounted to each carriage 62 at pivot pin 66. In the ultrasonic support subassembly 64, support arm 68 extends from pivot pin 66, toward outer working surface 32 of the work drum 26, and sup-

ports, at its remote end, a rotary ultrasonic horn 70 and ultrasonic generator 72. Support arm 68 is fixedly secured to control arm 74. Control arm 74 is operated by double acting air cylinder 76, acting through pivot pin 66 and control arm 74, to pivot the ultrasonic horn 70 about pivot pin 66 and thereby to raise and lower the ultrasonic horn 70 with respect to the outer working surface 32 of work drum 26. Thus, the ultrasonic support subassembly 64 comprises pivot pin 66, support arm 68, and control arm 74.

[0048] Compressed air is supplied to the air cylinder 76 from pneumatic control box 78. See Fig. 4. Compressed air is supplied to the pneumatic control box 78 through supply line 80, which is connected, through a conventional rotary pneumatic coupling to fixed shaft 30. Air is supplied through the center of fixed shaft 30 from a supply line 82.

[0049] Electric power is supplied to the ultrasonic system 24 through slip rings 84, and is communicated to the ultrasonic generators 72 through supply line 86.

[0050] Programmable limit switch 88 is also mounted to the driven shaft 50, for purpose to be discussed hereinafter. Output of the programmable limit switch 88 is fed to the control box 78 through electric line 90.

[0051] It is contemplated that the operation and functions of the invention have become fully apparent from the foregoing description of elements and their relationships with each other, but for completeness of disclosure, the usage of the invention will be briefly described.

[0052] Turning now to Fig. 4, driven shaft 50 turns end flange 48, work drum 26, support drum 38 and its supported carriages 62, ultrasonic support subassemblies 64, ultrasonic horns 70, and generators 72, continuously at a steady speed of rotation. An incoming turning roll 92 is disposed at a placing station, relative to a reference line through axis 28, at an angle "P" on the circumference of the work drum 26. A web 33 of workpieces or other material is fed, in the direction indicated by arrow 93 about incoming turning roll 92, and is thereby drawn into engagement with the working surface 32 of the work drum 26, at the nip formed between work drum 26 and turning roll 92, while the work drum is rotating in the direction indicated by the arrow 94. The web 33 is generally drawn about the circumference of work drum 26 at its outer working surface from incoming turning roll 92 until it reaches the outgoing turning roll 96, at the removing station disposed at an angle "R" on the circumference of the work drum 26. At outgoing turning roll 96, the web 33 turns about the turning roll 96 as indicated there by the web 33, and is thus removed from the work drum and exits the process of interest in this invention.

[0053] In general, as the invention is practiced, the ultrasonic horns are continuously activated, resonating at their designed frequencies.

[0054] Turning to the combination of Figs. 3-7, a slot opening 98 extends through the outer wall 46 of support drum 38 adjacent each carriage support track 60. A pair of cam followers 100 extends downwardly from each respective carriage, through slot opening 98, and engages the rib cam 56. Accordingly, as the working drum 26 and support drum 38 rotate on axis 28, about the stationary cam drum 54, the engagement of the cam followers 100 with the rib cam 56 causes the carriages 62 to move alternately toward and away from the outer working surface 32 of the work drum 26. Each carriage 62 thus makes one complete round trip motion, toward the work drum 26 and away from the work drum 26, for each 360 degree rotation of the work drum 26. Accordingly, and now referring to Figs. 3-5, the carriage 62A at the 12 o'clock position on support drum 38 is fully extended toward the work drum 26; and the carriage 62B at the 6 o'clock position on support drum 38 is fully withdrawn away from the work drum 26.

[0055] As the carriages 62 extend toward the work drum 26, the respective ultrasonic horns 70 extend over the outer working surface 32 of the work drum 26, and over the corresponding anvil bar 34. As the carriages 62 withdraw from the work drum 26, the respective ultrasonic horns 70 withdraw from over the outer working surface 32 of the work drum 26.

[0056] An ultrasonic horn 70 is considered fully withdrawn from over the outer working surface 32 when the remote outer edge 101 of the combination of the ultrasonic support assembly 64, horn 70, and generator 72, passes inwardly of the inner edges 102 of turning rolls 92 and 96. See Fig. 4, where the horn 70 on carriage 62B is fully withdrawn, and has moved still further away from the work drum 26 than the defined "fully withdrawn" position. Accordingly, "fully withdrawn" comprehends a range of positions of the outer edge 101 disposed inwardly of the inner edges 102 of the turning rolls 92 and 96, and is not limited to the innermost position where the carriage 62 is disposed in its most remote position with respect to the work drum 26.

[0057] As each carriage 62 extends toward the work drum 26, and the respective ultrasonic horn 70 is correspondingly disposed over the outer working surface 32, programmable limit switch 88 signals the pneumatic control box 78, thus activating and extending the ram 103 on the respective air cylinder 76 to thus move the respective resonating ultrasonic horn 70 downwardly, as shown by the double headed arrow indicated as 104 in Fig. 7, and into contact with the workpiece being carried in the web 33 at the respective work station 106 defined at each respective anvil bar 34. The rotary ultrasonic horn 70 exerts a downward force on the workpiece against the supporting resistance of the anvil bar 34. The amount of downward force is controlled by the force exerted at air cylinder 76.

[0058] With the resonating rotary ultrasonic horn 70 thus exerting a downward force on the workpiece, the circular rotary horn 70 is allowed to rotate about an axis 110 as it provides an effective application of ultrasonic energy to the workpiece at a point 112 moving progressively across the workpiece as the ultrasonic horn 70 traverses across the working surface 32 in an energy

application path 108. As indicated in Fig. 4, the energy application path can extend less than all the way across the web 33; or can extend all the way across the web 33, depending on what work is to be performed by the ultrasonic energy, and the lengths of carriage support tracks 60 and support arm 68.

[0059] Preferably, the ultrasonic horn 70 is forced downwardly into working contact with the workpiece while the horn 70 is traversing the outgoing segment of the energy application path 108. When the respective ultrasonic horn 70 reaches the outer extremity of the outgoing segment of the energy application path 108, limit switch 88 senses the respective associated angular position of the working station 106 with respect to axis 28, and signals the pneumatic control box 78, lifting the horn 70 from the workpiece as the horn 70 is being withdrawn from over the workpiece on the (reverse direction) incoming segment of the energy application path 108. Referring to Fig. 5, the horn 70 begins being extended over the drum 26, namely crossing the inner edge 102 of the turning rolls 92, 96 at an angle "E" on the outer circumference of the work drum 26, and is fully withdrawn from over the outer working surface 32 at an angle "W" on the outer circumference of the work drum 26. Referring to Fig. 5, it is seen that the respective horn assembly is fully withdrawn before the respective workpiece in web 33 arrives at the turning roll 96 where the workpiece and web 33 are removed from the work drum 26. Similarly, the horn assembly, comprising horn 70, generator 72, and ultrasonic support subassembly 64, remains fully withdrawn, and does not begin being extended over the outer working surface 32 until the horn assembly has passed the incoming turning roll 92 and the outer working surface 32 is again becoming engaged with the incoming web 33 of workpieces.

[0060] The working drum 26 thus rotates continuously, accompanied by the ultrasonic horns 70. Workpieces enter the ultrasonic system 24 as they are placed on the work drum 26 as part of web 33, and traverse the working path 114 between the placing station at angle "P" and the removing station at an angle "R," while the ultrasonic application devices, as horns 70 and anvils 34, form the welds 22. Each horn 70 thus extends across the outer working surface 32 at the respective anvil 34 to make a weld 22 in the workpiece with each rotation of the work drum 26. The welds 22 extend in the cross machine direction. At any given time, the combined apparatus can support performing welding, cutting, or the like operations on substantially as many workpieces as there are work stations 106, and corresponding workpieces, on the drum 26 between the turning rolls 92 and 96, allowing sufficient clearance for "full withdrawal" of the respective horns 70 from the outer working surface 32 so that the web 33 with the finished workpieces can be removed at turning roll 96.

[0061] Suitable rotary ultrasonic horns 70 are, for example, those taught in United States Patent 5,110,403 to Ehlert, herein incorporated by reference for its teaching with respect to suitable such rotary ultrasonic horns 70. Suitable ultrasonic generators 72, and other related ultrasonic equipment, is available from a variety of suppliers, for example, Sonic Power Company, Danbury, Connecticut.

[0062] Fig. 8 shows a second embodiment of the invention wherein the ultrasonic horn 70 and the cooperating anvil 34 are disposed in physically reversed locations from the embodiment of Figs. 3-7. Thus, comparing the embodiment of Fig. 8 to the embodiment described in more detail with respect to Figs. 3-7, in Fig. 8, a pair of conventional plunge-type ultrasonic horns 170 are mounted in the work drum 26 in place of the anvil bar 34. As many plunge type horns 170 can be used as necessary to span the full width of the energy application path 108. Correspondingly, a rotary anvil 134 is mounted to the ultrasonic support assembly 64 in place of the rotary ultrasonic horn 70.

[0063] In use, the ultrasonic horns 170 are preferably activated continuously during operation of the process. Work drum 26 and support drum 38 rotate continuously as described above. As the drums rotate, the anvil 134 is extended over the working surface, and forced into working contact with the workpieces by air cylinder 76 as the anvil 134 traverses the outgoing segment of the energy application path 108, and lifts the anvil 134 from the workpiece as it traverses the incoming segment of the energy application path 108. The significant difference is that the locations of the ultrasonic horn 170 and the anvil 134 are reversed, while the physical movement role of extending over the outer working surface 32 and subsequently withdrawing remains embodied in the elements mounted on carriage 62. Accordingly, the ultrasonic application device mounted in the outer working surface 32 of the work drum 26 is the device supplying the ultrasonic energy, rather than the ultrasonic application device mounted on the ultrasonic support subassembly 64.

[0064] Alternatively, other energy application devices may be substituted for the ultrasonic devices. Such devices include electric resistance heating elements, electric indicator elements, and fluid heated elements.

Claims

1. An energy system for applying energy to a workpiece comprising:

(a) a drum (26), mounted for rotation about a first axis (28) in a given direction, said drum (26) having a circumferential outer working surface (32);

(b) a first energy application device (34; 170), mounted on said drum (26) at said outer working surface (32), and extending transverse to the direction of rotation of said drum (26); and

(c) a second energy application device (70; 134), mounted for rotation with said drum (26), and for moving in a direction transverse to the direction of rotation of said drum (26) to thereby extend over said first energy application device (34; 170), and operate in combination with said first energy application device, to apply energy to the workpiece at a point (112) progressively moving across the workpiece during rotation of said drum (26), and for subsequently being disposed in a remote position with respect to the drum (26), thus withdrawing from over said first energy application device during rotation of said drum (26).

2. An energy system according to claim 1, wherein the first energy application device (34; 170) and the second energy application device (70;134) are suited for applying thermal energy to the workpiece and one of said first and second energy application devices (34, 70; 134, 170) comprises a horn (70; 170) adapted to provide thermal energy, the other of said energy application devices comprises an anvil (34; 134) adapted to cooperate with said horn (70; 170).

3. An energy system according to at least one of the preceding claims, wherein at least one of said first and second energy application devices is an ultrasonic application device, preferably an ultrasonic horn.

4. An energy system according to at least one of the preceding claims, wherein said thermal energy source is by electrical resistance and/or ultrasonic and/or electric indicator and/or fluid heat.

5. An energy system according to at least one of the preceding claims, wherein said first energy application device comprises said anvil (34), and said second energy application device comprises said horn (70).

6. An energy system according to at least one of the claims 1 to 4, said first energy application device comprising an ultrasonic horn (70), and said second energy application device comprising an anvil (34).

7. An energy system according to at least one of the preceding claims, said anvil (34) comprising a metal bar mounted essentially flush with said outer working surface (32) of said drum (26).

8. An energy system according to at least one of the preceding claims, said horn (70) being mounted to extend over said anvil (34), and to subsequently withdraw from over said anvil (34), during each rotation of said drum (26).

9. An energy system according to at least one of the preceding claims, said horn (70) being mounted to extend over said anvil (34), to apply pressure on a workpiece on said anvil (34), and thereby to apply thermal energy to the workpiece while extended over said anvil (34).

10. An energy system according to at least one of the preceding claims, said horn (70) being mounted to traverse an energy application path (108) over said anvil (34) and a workpiece on said anvil (34), the energy application path (108) extending transversely across the outer working surface (32), said energy system further comprising means for simultaneously applying pressure and thermal energy through said horn (70), to the workpiece disposed on said anvil (34), thereby to accomplish work on the workpiece while said horn (70) is so traversing the energy application path (108).

11. An energy system according to claim 10, said horn (70) comprising a wheel mounted for rotation about a second axis (110), to thereby apply thermal energy to the workpiece at a point (112) progressively moving across the workpiece as said horn (70) traverses said energy application path (108).

12. An energy system according to at least one of the preceding claims 10 or 11, said horn (70) comprising a rotary horn, preferably a rotary ultrasonic horn, said energy application path (108) including an outgoing segment wherein said rotary horn (70) is extended over said anvil (34) and an incoming segment wherein said rotary horn (70) is withdrawn from over said anvil (34), said energy system further comprising (a) means (76) for applying pressure through said rotary horn (70) to the workpiece as said horn (70) traverses said energy application path (108), and (b) control means (78) adapted to activate said means (76) for applying pressure, to thereby apply pressure through said rotary horn (70) to the workpiece on one of said segments of said energy application path (108) and to withhold the pressure on the other of said segments of said energy application path (108).

13. An energy system according to at least one of the preceding claims, said energy system comprising at least two said anvils (34) mounted at different radial locations about said outer working surface (32) of said drum (26), and corresponding at least two said rotary horns, preferably rotary ultrasonic horns, mounted for rotation with said drum (26) and over respective ones of said at least two anvils (34), said energy system further comprising control means including means (54, 56, 58, 60, 62) for controlling operation of all of said at least two rotary horns (70) such that the respective said rotary horn (70) begins

being extended over a respective said anvil (34) when the respective said anvil (34) is disposed at a locus corresponding to a first angle "E" measured with respect to a reference line passing through said first axis (28) of rotation and subsequently withdraws from over the respective said anvil (34) such that said rotary horn (70) is fully withdrawn when said drum (26) has rotated such that the respective said anvil (34) is disposed at a locus corresponding to a second angle "W" measured with respect to the reference line passing through said first axis of rotation, and wherein the same angles "E" and "W" apply for each of said at least two horns (70).

14. An energy system according to at least one of the preceding claims, said horn comprising a flat planar surface plunge-type horn (170), preferably a flat planar surface plunge-type ultrasonic horn, having a working surface (32), preferably an ultrasonic working surface, mounted essentially flush with said outer working surface (32) of said drum (26).

15. An energy system according to at least one of the preceding claims, said anvil (134) being mounted to extend over said horn (170), and to subsequently withdraw from over said horn (170), during each rotation of said drum (26).

16. An energy system according to at least one of the preceding claims, said anvil (134) being mounted to extend over said horn (170), to apply pressure on a workpiece on said horn (170), and thereby to apply thermal energy, preferably ultrasonic energy, to the workpiece while extended over said horn (170).

17. An energy system according to at least one of the preceding claims, said anvil (134) being mounted to traverse an energy application path (108) over said horn (170) and a workpiece on said horn (170), and to simultaneously apply pressure and thermal energy on the workpiece disposed on said horn (170), thereby to accomplish work on the workpiece while so traversing said horn (170).

18. An energy system according to at least one of the preceding claims, said anvil (134) comprising a wheel mounted for rotation about a second axis (110), such that the combination of said anvil (134) and said horn (170) provides effective thermal energy, preferably ultrasonic energy, to the workpiece at a point moving progressively across the workpiece as said anvil (134) traverses said energy application path (108).

19. An energy system according to at least one of the preceding claims, said anvil (134) comprising a rotary anvil (134), said energy application path (108) including an outgoing segment wherein said rotary anvil (134) is extended over said horn (170) and an incoming segment wherein said anvil (134) is withdrawn from over said horn (170), said energy system further comprising (a) means (76) for applying pressure through said rotary anvil (134) to the workpiece as the anvil (134) traverses said energy application path (108), and (b) control means (78) adapted to activate said means (76) for applying pressure, to thereby apply pressure through said rotary anvil (134) to the workpiece on one of said segments of said energy application path (108) and to withhold the downward pressure on the other of said segments of said energy application path (108).

20. An energy system according to at least one of the preceding claims, said anvil (134) comprising a rotary anvil (134), said energy application path (108) including an outgoing segment wherein said rotary anvil (134) is extended over said horn (170) and an incoming segment wherein said rotary anvil (134) is withdrawn from over said horn, said energy system further comprising (a) means (76) for applying downward pressure through said rotary anvil (134) to the workpiece as the anvil (134) traverses said energy application path (108), and (b) control means (78) adapted to activate said means (76) for applying downward pressure, to thereby apply downward pressure through said rotary anvil (134) to the workpiece on one of said segments of said energy application path (108) and to withhold the downward pressure on the other of said segments of said energy application path (108).

21. An energy system according to at least one of the preceding claims, said energy system comprising at least two said horns (170) mounted at different radial locations about said outer working surface (32) of said drum (26), and corresponding at least two said rotary anvils (134) mounted for rotation with said drum (26) and over respective ones of said at least two horns (170), said energy system further comprising control means including means (54, 56, 58, 60, 62) for controlling operation of all of said at least two rotary anvils (134) such that the respective said rotary anvil (134) begins being extended over a respective said horn (170) when the respective said anvil (134) is disposed at a locus corresponding to a first angle "E" measured with respect to a reference line passing through said first axis (28) of rotation and subsequently withdraws from over the respective said anvil (134) such that said rotary horn (170) is fully withdrawn from over the respective said horn when said drum (26) has rotated such that the respective said horn (170) is disposed at a second angle "W" measured with respect to the reference line passing through said first axis (28) of rotation, and wherein the same angles "E" and "W"

apply for each of said at least two horns (170).

22. An energy system according to at least one of the preceding claims, said energy system further comprising placing means (92) adjacent said drum (26), at a placing station disposed at an angle "P" measured with respect to a reference line passing through said first axis (28), for placing a workpiece onto a working station (106) of said outer working surface (32) where thermal energy, preferably ultrasonic energy, can be applied to the workpiece by said first and second ultrasonic application devices (34, 70; 134, 170); removing means (96) adjacent said drum (26), at a removing station disposed at an angle "R" measured with respect to the reference line passing through said first axis (28), for removing the workpiece from said outer working surface (32), such that the workpiece traverses a working path (114) on said outer working surface (32) about the circumference of said drum (26) from said placing station to said removing station; and control means for controlling movement of said second energy application device (70; 134) such that said second energy application device (70; 134) extends over said drum (26) and correspondingly over said first energy application device (34; 170) and the workpiece while the workpiece traverses said working path (114), and withdraws from over said drum (26) and said first energy application device (34; 170) while said working station (106) of said outer working surface (32) traverses from said removing station to said placing station.

23. An energy system according to at least one of the preceding claims, said energy system further comprising placing means (92) adjacent said drum (26), at a placing station disposed at an angle "P" measured with respect to a reference line passing through said first axis (28), for placing a workpiece onto a working station (106) of said outer working surface (32) where thermal energy can be applied to the workpiece by said first and second energy application devices (34, 70; 134, 170); removing means (96) adjacent said drum (26), at a removing station disposed at an angle "R" measured with respect to the reference line passing through said first axis (28), for removing the workpiece from said outer working surface (32), such that the workpiece traverses a working path (114) on said outer working surface (32) about the circumference of said drum (26) from said placing station to said removing station; and control means for controlling movement of said horn, preferably of said at least two horns, preferably of said rotary horn, such that said horn (70) extends over said drum (26) and correspondingly over said anvil (34) or anvils and the workpiece while the workpiece traverses said working path (114), and withdraws from over said drum (26) and said anvil (34) or anvils while said working station (106) of said outer working surface (32) traverses from said removing station to said placing station.

24. An energy system according to at least one of the preceding claims, said energy system further comprising placing means (92) adjacent said drum (26), at a placing station disposed at an angle "P" measured with respect to a reference line passing through said first axis (28), for placing a workpiece onto a working station (106) of said outer working surface (32) where thermal energy can be applied to the workpiece by said first and second ultrasonic application devices (34, 70; 134, 170); removing means adjacent said drum (26), at a removing station disposed at an angle "R" measured with respect to the reference line passing through said first axis (28), for removing the workpiece from said outer working surface (32), such that the workpiece traverses a working path (114) on said outer working surface (32) about the circumference of said drum (26) from said placing station to said removing station; and control means for controlling movement of said anvil (134) such that said anvil (134) extends over said drum (26) and correspondingly over said horn (170) and the workpiece while the workpiece traverses said working path (114) and is withdrawn from over said drum (26) and said horn (170) while said working station (106) of said outer working surface (32) traverses from said removing station to said placing station.

25. An energy system as in claim 24, wherein said control means controls movement of at least two anvils (134) such that said at least two anvils (134) extend over said drum (26) and correspondingly over said horns (170) and the workpiece while the workpiece traverses said working path (114) and is withdrawn from over said drum (26) and said horns (170) while said working station (106) of said outer working surface (32) traverses from said removing station to said placing station.

26. A method for applying thermal energy to a workpiece, the method comprising the steps of:

(a) rotating a drum about a first axis in a given direction, the drum having a circumferential outer working surface, a first energy application device mounted on the drum at the outer working surface and extending transverse to the direction of rotation of the drum;

(b) providing a second energy application device, mounted for rotation with the drum;

(c) moving the second energy application de-

vice in a direction transverse to the direction of rotation of the drum and thereby extending the second energy application device over the first energy application device and operating the first and second energy application devices in combination, thereby applying thermal energy to the workpiece at a point moving progressively across the workpiece during rotation of the drum; and

(d) disposing the second energy application device in a remote position with respect to the drum, thus withdrawing the second energy application device from over the first energy application device during rotation of the drum,

one of the first and second energy application devices comprising a horn adapted to provide thermal energy, the other of the energy application devices comprising an anvil adapted to cooperate with the horn.

27. The method as recited in claim 26, wherein at least one of said energy devices is an ultrasonic application device, preferably an ultrasonic horn.

28. The method according to at least one of claims 26 or 27, wherein said thermal energy source is by electrical resistance and/or ultrasonic and/or electric indicator and/or fluid heat.

29. The method according to at least one of claims 26 to 28, including applying thermal energy to said workpiece through said second energy application device.

30. The method according to at least one of claims 26 to 29, including extending the second energy application device over the first energy application device, and subsequently withdrawing the second energy application device from over the first energy application device, during each rotation of the drum.

31. The method according to at least one of claims 26 to 30, including extending the second energy application device over the first energy application device, and applying pressure on a workpiece on the first energy application device, and thereby applying thermal energy to the workpiece.

32. The method according to at least one of claims 26 to 31, including traversing the second energy application device along an energy application path over the first energy application device and a workpiece on the first energy application device and simultaneously applying pressure and thermal energy on the workpiece disposed on the first energy application device, and thereby accomplishing work on the workpiece while so traversing the energy application path.

33. The method according to claim 32, the first energy application device comprising an anvil, the second energy application device comprising a rotary ultrasonic horn comprising a wheel mounted for rotation about a second axis, said method comprising applying thermal energy to the workpiece at a point moving progressively across the workpiece as the second energy application device traverses the energy application path.

34. The method according to at least one of claims 32 to 33, including applying pressure, through the second energy application device to the workpiece as the second energy application device traverses the energy application path.

35. The method according to at least one of claims 32 to 34, the energy application path including an outgoing segment wherein the second energy application device is being extended over the first energy application device and an incoming segment wherein the second energy application device is being withdrawn from over the first energy application device, the method further comprising controlling the second energy application device and thereby applying pressure through the second energy application device to the workpiece on one of the segments of the energy application path and withholding the pressure on the other of the segments of the energy application path.

36. The method according to at least one of claims 32 to 35, the energy application path including an outgoing segment wherein a rotary ultrasonic horn is being extended out over an anvil and an incoming segment wherein the rotary ultrasonic horn is being withdrawn from over the anvil, the method further comprising controlling the rotary ultrasonic horn and thereby applying pressure through the rotary ultrasonic horn to the workpiece on one of the segments of the energy application path and withholding the pressure on the other of the segments of the energy application path.

37. A method for applying thermal energy to a workpiece, especially according to at least one of claims 26 to 36 using an energy system according to at least one of claims 1 to 25.

38. The method as in claim 37, said energy system, preferably ultrasonic system, comprising at least two first energy application devices mounted at different radial locations about the outer working surface of the drum, and corresponding at least two second energy application devices mounted for ro-

tation with the drum and over respective ones of the at least two first energy application devices, and including controlling operation of all of the at least two second energy application devices and thereby beginning to extend each second energy application device over a respective first energy application device when the respective first energy application device is disposed at a locus corresponding to a first angle "E" measured with respect to a reference line passing through the first axis of rotation, rotating the drum, and subsequently beginning withdrawal of the respective second energy application device from over the respective first energy application device such that the second energy application device is fully withdrawn from over the respective first energy application device when the drum has rotated such that the first energy application device is disposed at a second angle "W" measured with respect to the reference line passing through the first axis of rotation, and wherein the same angles "E" and "W" measured with respect to the reference line passing through the first axis of rotation, apply for each of the at least two second energy application devices.

39. The method according to at least one of claims 26 to 38, including placing a workpiece onto a working station of the outer working surface at an angle "P" measured with respect to a reference line passing through the first axis; rotating the drum; while rotating the drum, controlling movement of the second energy application device and thereby extending the second energy application device over the drum and correspondingly over the workpiece; and withdrawing the second energy application device from over the drum such that the second energy application device is withdrawn from over the drum while the working station of the outer working surface traverses from the removing station to the placing station.

Patentansprüche

1. Energiesystem zum Zuführen von Energie zu einem Werkstück, umfassend:

(a) eine Trommel (26), zur Drehung um eine erste Achse (28) in einer gegebenen Richtung angebracht, wobei die Trommel (26) eine Arbeitsoberfläche auf dem äußeren Umfang (32) aufweist;

(b) eine erste Energiezufuhrvorrichtung (34; 170), die auf der Trommel (26) an der äußeren Arbeitsoberfläche (32) angebracht ist und sich quer zur Drehrichtung der Trommel (26) erstreckt; und

(c) eine zweite Energiezufuhrvorrichtung (70; 134), die zur Drehung mit der Trommel (26) angebracht ist und die sich in eine Richtung quer zur Drehrichtung der Trommel (26) bewegen kann, um dabei über die erste Energiezufuhrvorrichtung (34; 170) zu verfahren und in Verbindung mit der ersten Energiezufuhrvorrichtung wirksam zu werden, um Energie zu dem Werkstück an einem Punkt (112) zuzuführen, wobei sich dieser Punkt fortschreitend über das Werkstück während der Drehung der Trommel (26) bewegt, und die zweite Energiezufuhrvorrichtung in weiterer Folge in einer in Bezug auf die Trommel (26) entfernten Position angeordnet wird, wodurch sie sich von der Position über der ersten Energiezufuhrvorrichtung während der Drehung der Trommel (26) zurückzieht.

2. Energiesystem nach Anspruch 1, wobei die erste Energiezufuhrvorrichtung (34; 170) und die zweite Energiezufuhrvorrichtung (70; 134) zur Zuführung thermischer Energie zu einem Werkstück geeignet sind Energiezufuhrvorrichtungen (34, 70; 134, 170) ein Horn umfasst (70; 170), das vorgesehen ist, um thermische Energie bereitzustellen, wobei die andere Energiezufuhrvorrichtung einen Amboss (34; 134) umfasst, der für das Zusammenwirken mit dem Horn (70; 170) vorgesehen ist.

3. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei zumindest eine der ersten und zweiten Energiezufuhrvorrichtungen eine Ultraschallzufuhrvorrichtung ist, vorzugsweise ein Ultraschallhorn.

4. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei die thermische Energiequelle aus einem elektrischen Widerstand und/oder Ultraschall und/oder einem elektrischen Indikator und/oder Wärme eines Fluids besteht.

5. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei die erste Energiezufuhrvorrichtung den Amboss (34) und die zweite Energiezufuhrvorrichtung das Horn (70) umfasst.

6. Energiesystem nach zumindest einem der Ansprüche 1 bis 4, wobei die erste Energiezufuhrvorrichtung ein Ultraschallhorn (70) und die zweite Energiezufuhrvorrichtung einen Amboss (34) umfasst.

7. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei der Amboss (34) eine Metallstange umfasst, die im Wesentlichen bündig mit der äußeren Arbeitsfläche (32) der Trommel (26) angebracht ist.

8. Energiesystem nach zumindest einem der vorange-

henden Ansprüche, wobei das Horn (70) angebracht ist, um über den Amboss (34) zu verfahren und sich in weiterer Folge von der Position über dem Amboss (34) während jeder Umdrehung der Trommel (26) zurückzuziehen.

9. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei das Horn (70) angebracht ist, um über den Amboss (34) zu verfahren, um Druck auf das Werkstück auf dem Amboss (34) auszuüben und dadurch thermische Energie dem Werkstück zuzuführen, während es über den Amboss (34) ragt.

10. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei das Horn (70) angebracht ist, um über einen Energiezufuhrpfad (108) über dem Amboss (34) und einem Werkstück auf dem Amboss (34) zu verfahren, wobei der Energiezufuhrpfad (108) sich quer über die äußere Arbeitsfläche (32) erstreckt, wobei das Energiesystem des Weiteren Mittel zum gleichzeitigen Ausüben von Druck und Zuführen thermischer Energie durch das Horn (70) zu dem Werkstück, das auf dem Amboss (34) angeordnet ist, umfasst, um dadurch Arbeit auf dem Werkstück zu verrichten, während das Horn (70) so den Energiezufuhrpfad (108) quert.

11. Energiesystem nach dem Anspruch 10, wobei das Horn (70) ein Rad umfasst, das vorgesehen für die Drehung um eine zweite Achse (110) angebracht ist, um dadurch thermische Energie zu einem Werkstück an einem Punkt (112) zuzuführen, der sich fortschreitend über das Werkstück bewegt, während das Horn (70) den Energiezufuhrpfad (108) quert.

12. Energiesystem nach zumindest einem der vorangehenden Ansprüche 10 oder 11, wobei das Horn (70) ein Drehhorn, vorzugsweise ein Ultraschalldrehhorn, umfasst, wobei der Energiezufuhrpfad (108) ein hinauslaufendes Segment, in dem das Drehhorn (70) über dem Amboss (34) erstreckt ist, und ein hereinlaufendes Segment umschließt, in dem das Drehhorn (70) von der Position über dem Amboss (34) zurückgezogen ist, wobei das Energiesystem des Weiteren (a) Mittel (76) zum Ausüben von Druck auf das Werkstück durch das Drehhorn (70), während das Drehhorn (70) den Energiezufuhrpfad (108) quert, und (b) Steuermittel (78) zur Inbetriebnahme der Mittel (76) zur Druckausübung umfasst, um dadurch Druck durch das Drehhorn (70) auf das Werkstück auf einem der Segmente des Energiezufuhrpfads (108) zuzuführen und den Druck auf dem anderen der Segmente des Energiezufuhrpfads (108) zurückzuhalten.

13. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei das Energiesystem zumindest zwei Ambosse (34), die an unterschiedlichen radialen Stellen um die äußere Arbeitsfläche (32) der Trommel (26) angeordnet sind, und zumindest zwei zugeordnete Drehhörner, vorzugsweise Ultraschalldrehhörner, umfasst, die zur Drehung mit der Trommel (26) und über den jeweils zugehörigen Amboss der zumindest zwei Ambosse (34) angebracht sind, wobei das Energiesystem des Weiteren Steuermittel umfasst, welche die Mittel (54, 56, 58, 60, 62) zum Steuern des Betriebs aller der zumindest zwei Drehhörner (70) miteinschließen, so dass das entsprechende Drehhorn (70) über einen entsprechenden Amboss (34) zu verfahren beginnt, wenn der entsprechende Amboss (34) an einem Ort angeordnet ist, der einem ersten Winkel "E" entspricht, der mit Bezug auf eine Bezugslinie, die durch die erste Achse (28) der Drehung hindurchgeht, gemessen wird, und sich in weiterer Folge von der Position über dem jeweiligen Amboss (34) zurückzieht, so dass das Drehhorn (70) vollständig zurückgezogen ist, wenn sich die Trommel (26) so gedreht hat, dass der entsprechende Amboss (34) an einem Ort angeordnet ist, der einem zweiten Winkel "W" entspricht, der mit Bezug auf die Bezugslinie, die durch die erste Achse der Drehung hindurchgeht, gemessen wird, und wobei dieselben Winkel "E" und "W" für jedes von zumindest zwei Hörnern (70) gelten.

14. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei das Horn ein Horn (170) vom Stösseltyp mit flacher, ebener Fläche, vorzugsweise ein Ultraschallhorn vom Stösseltyp mit flacher, ebener Fläche, mit einer Arbeitsfläche (32) ist, vorzugsweise eine Ultraschallarbeitsfläche, das im Wesentlichen bündig mit der äußeren Arbeitsfläche (32) der Trommel (26) angebracht ist.

15. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei der Amboss (134) so angebracht ist, dass er über das Horn (170) verfährt und sich in weiterer Folge von der Position über dem Horn (170) während jeder Umdrehung der Trommel (26) zurückzieht.

16. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei der Amboss (134) so angebracht ist, um über das Horn (170) zu verfahren, um Druck auf das Werkstück auf dem Horn (170) auszuüben und dadurch thermische Energie, vorzugsweise Ultraschallenergie, zu dem Werkstück zuzuführen, während er über dem Horn (170) erstreckt ist.

17. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei der Amboss (134) so angebracht ist, um einen Energiezufuhrpfad (108)

über dem Horn (170) und einem Werkstück auf dem Horn (170) zu queren und gleichzeitig Druck auszuüben und thermische Energie auf dem Werkstück, das auf dem Horn (170) angeordnet ist, zu führen, wodurch Arbeit an dem Werkstück verrichtet wird, während so das Horn (170) gequert wird.

18. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei der Amboss (134) ein Rad umfasst, das vorgesehen für die Drehung um eine zweite Achse (110) angebracht ist, so dass die Verbindung von Amboss (134) und Horn (170) wirksame thermische Energie, vorzugsweise Ultraschallenergie, auf einem Werkstück an einem Punkt bereitstellt, der sich fortschreitend über das Werkstück bewegt, während der Amboss (134) den Energiezufuhrpfad (108) abfährt.

19. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei der Amboss (134) einen Drehamboss (134) umfasst, wobei der Energiezufuhrpfad (108) ein hinauslaufendes Segment, in dem der Drehamboss (134) über dem Horn (170) erstreckt ist, und ein hereinlaufendes Segment umschließt, in dem der Drehamboss (134) von der Position über dem Horn (170) zurückgezogen ist, wobei das Energiesystem des Weiteren (a) Mittel (76) zum Ausüben von Druck auf das Werkstück durch den Drehamboss (134), während der Amboss (134) dem Energiezufuhrpfad (108) folgt, und (b) Steuermittel (78) zur Inbetriebnahme der Mittel (76) zur Druckausübung umfasst, um dadurch Druck durch den Drehamboss (134) auf das Werkstück auf einem der Segmente des Energiezufuhrpfads (108) aufzubringen und den nach unten gerichteten Druck auf dem anderen der Segmente des Energiezufuhrpfads (108) zurückzuhalten.

20. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei der Amboss (134) einen Drehamboss (134) umfasst, wobei der Energiezufuhrpfad (108) ein hinauslaufendes Segment, in dem der Drehamboss (134) über dem Horn (170) erstreckt ist, und ein hereinlaufendes Segment umschließt, in dem der Drehamboss (134) von der Position über dem Horn zurückgezogen ist, wobei das Energiesystem des Weiteren (a) Mittel (76) zum Ausüben von nach unten gerichtetem Druck auf das Werkstück durch den Drehamboss (134), während der Amboss (134) dem Energiezufuhrpfad (108) folgt, und (b) Steuermittel (78) zur Inbetriebnahme der Mittel (76) zur Druckausübung nach unten umfasst, um dadurch einen nach unten gerichteten Druck durch den Drehamboss (134) auf das Werkstück auf einem der Segmente des Energiezufuhrpfads (108) aufzubringen und den nach unten gerichteten Druck auf dem anderen der Segmente des Energiezufuhrpfads (108) zurückzuhalten.

21. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei das Energiesystem zumindest zwei Hörner (170), die an unterschiedlichen radialen Stellen um die äußere Arbeitsfläche (32) der Trommel (26) angeordnet sind, und zumindest zwei zugeordnete Drehambosse (134) umfasst, die zur Drehung mit der Trommel (26) und über den jeweils zugehörigen zumindest zwei Hörnern (170) angebracht sind, wobei das Energiesystem des Weiteren Steuermittel umfasst, welche die Mittel (54, 56, 58, 60, 62) zum Steuern des Betriebs aller der zumindest zwei Drehambosse (134) miteinschließen, so dass der entsprechende Drehamboss (134) über ein entsprechendes Horn (170) zu verfahren beginnt, wenn der entsprechende Amboss (134) an einem Ort angeordnet ist, der einem ersten Winkel "E" entspricht, der mit Bezug auf eine Bezugslinie, die durch die erste Achse (28) der Drehung hindurchgeht, gemessen wird, und sich in weiterer Folge von der Position über dem jeweiligen Amboss (134) zurückzieht, so dass das Drehhorn (170) vollständig von der Position über dem jeweiligen Horn zurückgezogen ist, wenn sich die Trommel (26) so gedreht hat, dass das entsprechende Horn (170) in einem zweiten Winkel "W" angeordnet ist, der mit Bezug auf die Bezugslinie, die durch die erste Achse (28) der Drehung hindurchgeht, gemessen wird, und wobei dieselben Winkel "E" und "W" für jedes von zumindest zwei Hörnern (170) gelten.

22. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei das Energiesystem des Weiteren umfasst: Anordnungsmittel (92) benachbart zur Trommel (26) an einer Bereitstellungsstation, die in einem Winkel "P" angeordnet ist, der mit Bezug auf eine Bezugslinie, die durch die erste Achse (28) der Drehung hindurchgeht, gemessen wird, zum Anordnen eines Werkstücks auf einer Bearbeitungsstation (106) der äußeren Arbeitsfläche (32), wo thermische Energie, vorzugsweise Ultraschallenergie, dem Werkstück durch erste und zweite Ultraschallzufuhrvorrichtungen (34, 70; 134, 170) zugeführt werden kann; Abnahmemittel (96) benachbart zur Trommel (26) an einer Abnahmestation, die in einem Winkel "R" angeordnet ist, der mit Bezug auf eine Bezugslinie, die durch die erste Achse (28) der Drehung hindurchgeht, gemessen wird, zum Abnehmen eines Werkstücks von der äußeren Arbeitsfläche (32), so dass das Werkstück einen Bearbeitungspfad (114) auf der äußeren Arbeitsfläche (32) um den Umfang der Trommel (26) von der Anordnungsstation zur Abnahmestation zurücklegt; und Steuermittel zum Steuern der Bewegung der zweiten Energiezufuhrvorrichtung (70; 134), so dass die zweite Energiezufuhrvorrichtung (70; 134). über die Trommel (26) und entsprechend über die erste Energiezufuhrvorrichtung (34; 170)

und das Werkstück verfährt, während das Werkstück den Bearbeitungspfad (114) zurücklegt, und sich dann von der Position über der Trommel (26) und der ersten Energiezufuhrvorrichtung (34; 170) zurückzieht, während die Bearbeitungsstation (106) der äußeren Arbeitsfläche (32) von der Abnahmestation zur Anordnungsstation verfährt.

23. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei das Energiesystem des Weiteren umfasst: Anordnungsmittel (92) benachbart zur Trommel (26) an einer Bereitstellungsstation, die in einem Winkel "P" angeordnet ist, der mit Bezug auf eine Bezugslinie, die durch die erste Achse (28) der Drehung hindurchgeht, gemessen wird, zum Anordnen eines Werkstücks auf einer Bearbeitungsstation (106) der äußeren Arbeitsfläche (32), wo thermische Energie zu dem Werkstück durch die ersten und zweiten Energiezufuhrvorrichtungen (34, 70; 134, 170) zugeführt werden kann; Abnahmemittel (96) benachbart zur Trommel (26) an einer Abnahmestation, die in einem Winkel "R" angeordnet ist, der mit Bezug auf eine Bezugslinie, die durch die erste Achse (28) hindurchgeht, gemessen wird, zum Abnehmen eines Werkstücks von der äußeren Arbeitsfläche (32), so dass das Werkstück einen Bearbeitungspfad (114) auf der äußeren Arbeitsfläche (32) um den Umfang der Trommel (26) von der Anordnungsstation zur Abnahmestation zurücklegt; und Steuermittel zum Steuern der Bewegung des Horns, vorzugsweise der zumindest zwei Hörner, vorzugsweise des Drehhorns, so dass das Horn (70) über die Trommel (26) und entsprechend über den Amboss(34) oder die Ambosse und das Werkstück verfährt, während das Werkstück den Bearbeitungspfad (114) zurücklegt, und sich dann von der Position über der Trommel (26) und dem Amboss (34) oder den Ambossen zurückzieht, während die Bearbeitungsstation (106) der äußeren Arbeitsfläche (32) von der Abnahmestation zur Anordnungsstation verfährt.

24. Energiesystem nach zumindest einem der vorangehenden Ansprüche, wobei das Energiesystem des Weiteren umfasst: Anordnungsmittel (92) benachbart zur Trommel (26) an einer Bereitstellungsstation, die in einem Winkel "P" angeordnet ist, der mit Bezug auf eine Bezugslinie, die durch die erste Achse (28) hindurchgeht, gemessen wird, zum Anordnen eines Werkstücks auf einer Bearbeitungsstation (106) der äußeren Arbeitsfläche (32), wo thermische Energie dem Werkstück durch die ersten und die zweiten UltraschallZuführungsvorrichtungen (34, 70; 134, 170) zugeführt werden kann; Abnahmemittel (96) benachbart zur Trommel (26) an einer Abnahmestation, die in einem Winkel "R" angeordnet ist, der mit Bezug auf eine Bezugslinie, die durch die erste Achse (28) hindurchgeht, gemessen wird, zum Abnehmen eines Werkstücks von der äußeren Arbeitsfläche (32), so dass das Werkstück einen Bearbeitungspfad (114) auf der äußeren Arbeitsfläche (32) um den Umfang der Trommel (26) von der Anordnungsstation zur Abnahmestation zurücklegt; und Steuermittel zum Steuern der Bewegung des Ambosses (134), so dass der Amboss (134) über die Trommel (26) und entsprechend über das Horn (170) und das Werkstück verfährt, während das Werkstück den Bearbeitungspfad (114) zurücklegt, und dann von der Position über der Trommel (26) und dem Horn (170) zurückgezogen wird, während die Bearbeitungsstation (106) der äußeren Arbeitsfläche (32) von der Abnahmestation zur Anordnungsstation verfährt.

25. Energiesystem nach Anspruch 24, wobei das Steuermittel die Bewegung von zumindest zwei Ambossen (134) steuert, so dass die zumindest zwei Ambosse (134) über die Trommel (26) und entsprechend über die Hörner (170) und das Werkstück verfahren, während das Werkstück den Bearbeitungspfad (114) zurücklegt, und dann von der Position über der Trommel (26) und den Hörnern (170) zurückgezogen wird, während die Bearbeitungsstation (106) der äußeren Arbeitsfläche (32) von der Abnahmestation zur Anordnungsstation verfährt.

26. Verfahren zur Zuführung thermischer Energie zu einem Werkstück, umfassend die Schritte:

(a) Drehen einer Trommel um eine erste Achse in einer gegebenen Richtung, wobei die Trommel eine Arbeitsoberfläche auf dem äußeren Umfang und eine erste Energiezufuhrvorrichtung aufweist, die auf der Trommel an der äußeren Arbeitsfläche angebracht ist und sich quer zur Drehrichtung der Trommel erstreckt;

(b) Bereitstellen einer zweiten Energiezufuhrvorrichtung, die zur Drehung mit der Trommel angebracht ist;

(c) Bewegen der zweiten Energiezufuhrvorrichtung in eine Richtung quer zur Drehrichtung der Trommel und dadurch Verfahren der zweiten Energiezufuhrvorrichtung über die ersten Energiezufuhrvorrichtung und gemeinsames Betreiben der ersten und zweiten Energiezufuhrvorrichtung und dadurch Zuführen von thermischer Energie zu einem Werkstück an einem Punkt, der sich fortschreitend über das Werkstück während der Drehung der Trommel bewegt; und

(d) Anordnen der zweiten Energiezufuhrvorrichtung in einer in Bezug auf die Trommel entfernten Position, dadurch Zurückziehen der

zweiten Energiezufuhrvorrichtung von der Position über der ersten Energiezufuhrvorrichtung während der Drehung der Trommel,

wobei eine der ersten oder zweiten Energiezufuhrvorrichtungen ein Horn umfasst, das zur Bereitstellung thermischer Energie vorgesehen ist, wobei die andere der Energiezufuhrvorrichtungen einen Amboss umfasst, der zum Zusammenwirken mit dem Horn vorgesehen ist.

27. Verfahren nach Anspruch 26, wobei zumindest eine der Energievorrichtungen eine Ultraschallzufuhrvorrichtung ist, vorzugsweise ein Ultraschallhorn.

28. Verfahren nach zumindest einem der Ansprüche 26 oder 27, wobei die thermische Energiequelle aus einem elektrischen Widerstand und/oder Ultraschall und/oder einem elektrischen Indikator und/oder erwärmtem Wärme eines Fluids besteht.

29. Verfahren nach zumindest einem der Ansprüche 26 bis 28, umfassend das Zuführen thermischer Energie zu dem Werkstück durch die zweite Energiezufuhrvorrichtung.

30. Verfahren nach zumindest einem der Ansprüche 26 bis 29, umfassend das Verfahren der zweiten Energiezufuhrvorrichtung über die erste Energiezufuhrvorrichtung und das darauffolgende Zurückziehen der zweiten Energiezufuhrvorrichtung von der Position über der ersten Energiezufuhrvorrichtung während jeder Umdrehung der Trommel.

31. Verfahren nach zumindest einem der Ansprüche 26 bis 30, umfassend das Verfahren der zweiten Energiezufuhrvorrichtung über die erste Energiezufuhrvorrichtung und das Ausüben von Druck auf ein Werkstück auf der ersten Energiezufuhrvorrichtung und das dadurch erfolgende Zuführen thermischer Energie zu dem Werkstück.

32. Verfahren nach zumindest einem der Ansprüche 26 bis 31, umfassend das Überfahren der zweiten Energiezufuhrvorrichtung entlang eines Energiezufuhrpfads über die erste Energiezufuhrvorrichtung und ein Werkstück auf der ersten Energiezufuhrvorrichtung und das gleichzeitige Ausüben von Druck und das Zuführen thermischer Energie zu dem Werkstück, das auf der ersten Energiezufuhrvorrichtung angeordnet ist, und dadurch das Verrichten von Arbeit an dem Werkstück während des Abfahrens des Energiezufuhrpfads.

33. Verfahren nach Anspruch 32, wobei die erste Energiezufuhrvorrichtung einen Amboss, die zweite Energiezufuhrvorrichtung ein drehbares Ultraschallhorn umfasst, das ein Rad umfasst, das angebracht ist, um sich um eine zweite Achse zu drehen, wobei das Verfahren das Zuführen thermischer Energie zu dem Werkstück an einem Punkt umfasst, der sich fortschreitend über das Werkstück bewegt, während die zweite Energiezufuhrvorrichtung den Energiezufuhrpfad abfährt.

34. Verfahren nach zumindest einem der Ansprüche 32 bis 33, umfassend das Ausüben von Druck durch die zweite Energiezufuhrvorrichtung auf das Werkstück, während die zweite Energiezufuhrvorrichtung den Energiezufuhrpfad abfährt.

35. Verfahren nach zumindest einem der Ansprüche 32 bis 34, wobei der Energiezufuhrpfad ein hinauslaufendes Segment, in dem die zweite Energiezufuhrvorrichtung über die erste Energiezufuhrvorrichtung erstreckt ist, und ein hereinlaufendes Segment umfasst, in dem die zweite Energiezufuhrvorrichtung von der Position über der ersten Energiezufuhrvorrichtung zurückgezogen ist, wobei das Verfahren des Weiteren das Steuern der zweiten Energiezufuhrvorrichtung und dadurch das Ausüben von Druck durch die zweite Energiezufuhrvorrichtung auf das Werkstück auf einem der Segmente des Energiezufuhrpfads und das Zurückhalten des Drucks auf dem anderen der Segmente des Energiezufuhrpfads umfasst.

36. Verfahren nach zumindest einem der Ansprüche 32 bis 35, wobei der Energiezufuhrpfad ein hinauslaufendes Segment, in dem ein Ultraschalldrehhorn über einen Amboss erstreckt ist, und ein hereinlaufendes Segment umfasst, in dem das Ultraschalldrehhorn von der Position über dem Amboss zurückgezogen ist, wobei das Verfahren des Weiteren das Steuern des Ultraschalldrehhorns und dadurch das Ausüben von Druck durch das Ultraschalldrehhorn auf das Werkstück auf einem der Segmente des Energiezufuhrpfads und das Zurückhalten des Drucks auf dem anderen der Segmente des Energiezufuhrpfads umfasst.

37. Verfahren zur Zuführung thermischer Energie zu einem Werkstück, insbesondere nach zumindest einem der Ansprüche 26 bis 36 unter Verwendung eines Energiesystems nach einem der Ansprüche 1 bis 25.

38. Verfahren wie in Anspruch 37, wobei das Energiesystem, vorzugsweise ein Ultraschallsystem, zumindest zwei erste Energiezufuhrvorrichtungen, die an unterschiedlichen radialen Stellen um die äußere Arbeitsoberfläche der Trommel angebracht sind, und zumindest zwei zugeordnete zweite Energiezufuhrvorrichtungen umfasst, die zur Drehung mit der Trommel und über den jeweils zugehörigen zumindest zwei ersten Energiezufuhrvorrichtungen

angebracht sind, wobei das Energiesystem Steuertätigkeiten aller der zumindest zwei zweiten Energiezufuhrvorrichtungen umfasst und dabei jede zweite Energiezufuhrvorrichtung über eine entsprechend zugeordnete erste Energiezufuhrvorrichtung zu verfahren beginnt, wenn die entsprechende erste Energiezufuhrvorrichtung an einem Ort angeordnet ist, der einem ersten Winkel "E" entspricht, der mit Bezug auf eine Bezugslinie, die durch die erste Achse der Drehung hindurchgeht, gemessen wird, und es das Drehen der Trommel und darauffolgend das Zurückziehen der jeweiligen zweiten Energiezufuhrvorrichtung von der Position über der ersten Energiezufuhrvorrichtung umfasst, so dass die zweite Energiezufuhrvorrichtung vollständig von der Position über der ersten Energiezufuhrvorrichtung zurückgezogen ist, wenn sich die Trommel so gedreht hat, dass die erste Energiezufuhrvorrichtung in einem zweiten Winkel "W" angeordnet ist, der mit Bezug auf die Bezugslinie, die durch die erste Achse der Drehung hindurchgeht, gemessen wird, und wobei dieselben Winkel "E" und "W", die mit Bezug auf die Bezugslinie, die durch die erste Achse der Drehung hindurchgeht, gemessen werden, für jede der zumindest zwei zweiten Energiezufuhrvorrichtungen gelten.

39. Verfahren nach zumindest einem der Ansprüche 26 bis 38, umfassend das Anordnen eines Werkstücks auf einer Bearbeitungsstation der äußeren Arbeitsoberfläche in einem Winkel "P", der mit Bezug auf eine Bezugslinie, die durch die erste Achse der Drehung hindurchgeht, gemessen wird; Drehen der Trommel; während des Drehens der Trommel Steuern der Bewegung der zweiten Energiezufuhrvorrichtung und dadurch Verfahren der zweiten Energiezufuhrvorrichtung über die Trommel und entsprechend über das Werkstück und Zurückziehen der zweiten Energiezufuhrvorrichtung von der Position über der Trommel, so dass die zweite Energiezufuhrvorrichtung von der Position über der Trommel zurückgezogen ist, während die Bearbeitungsstation der äußeren Arbeitsoberfläche von der Abnahmestation zur Anordnungsstation verfährt.

Revendications

1. Système énergétique pour appliquer une énergie à une pièce à travailler, comprenant :

a) un tambour (26), monté rotatif autour d'un premier axe (28) dans une direction donnée, ledit tambour (26) présentant une surface de travail circonférencielle externe (32);
b) un premier dispositif d'application d'énergie (34 ; 170), monté sur ledit tambour (26) au niveau de ladite surface de travail externe (32), et s'étendant transversalement à la direction de rotation dudit tambour (26) ; et
c) un second dispositif d'application d'énergie (70 ; 134), monté de manière à tourner avec ledit tambour (26), et à se déplacer dans une direction transversale à la direction de rotation dudit tambour (26) pour ainsi s'étendre au-dessus dudit premier dispositif d'application d'énergie (34 ; 170), et fonctionner en combinaison avec ledit premier dispositif d'application d'énergie, pour appliquer à une pièce à travailler une énergie en un point (112) se déplaçant progressivement d'un côté à l'autre de la pièce à travailler pendant la rotation dudit tambour (26), et de manière à se trouver par la suite en retrait par rapport au tambour (26), se retirant ainsi de dessus ledit premier dispositif d'application d'énergie pendant la rotation dudit tambour (26).

2. Système énergétique selon la revendication 1, dans lequel le premier dispositif d'application d'énergie (34 ; 170) et le second dispositif d'application d'énergie (70 ; 134) conviennent à l'application d'énergie thermique à la pièce à travailler et dans lequel l'un desdits premier et second dispositifs d'application d'énergie (34, 70 ; 134, 170) consiste en une corne (70 ; 170) conçue pour fournir une énergie thermique, l'autre desdits dispositifs d'application d'énergie consiste en une enclume (34 ; 134) conçue pour coopérer avec ladite corne (70 ; 170).

3. Système énergétique selon l'une au moins des revendications précédentes, dans lequel au moins l'un desdits premier et second dispositifs d'application d'énergie est un dispositif d'application d'ultrasons, de préférence une sonotrode.

4. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite énergie thermique est produite par résistance électrique et/ou par ultrasons et/ou par induction électrique et/ou par fluide calorifique.

5. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ledit premier dispositif d'application d'énergie consiste en ladite enclume (34), et ledit second dispositif d'application d'énergie consiste en ladite corne (70).

6. Système énergétique selon l'une au moins des revendications 1 à 4, dans lequel ledit premier dispositif d'application d'énergie consiste en une sonotrode (70), et ledit second dispositif d'application d'énergie consiste en une enclume (34).

7. Système énergétique selon l'une au moins des re-

vendications précédentes, dans lequel ladite enclume (34) est constituée d'un barreau métallique monté essentiellement à fleur de ladite surface de travail externe (32) dudit tambour (26).

8. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite corne (70) est montée de manière à s'étendre au-dessus de ladite enclume (34), et à ensuite se retirer de dessus ladite enclume (34), pendant chaque rotation dudit tambour (26).

9. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite corne (70) est montée de manière à s'étendre au-dessus de ladite enclume (34), pour appliquer une pression à une pièce à travailler placée sur ladite enclume (34), et ainsi appliquer à la pièce à travailler une énergie thermique alors que ladite corne s'étend au-dessus de ladite enclume (34).

10. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite corne (70) est montée de manière à parcourir un chemin d'application d'énergie (108) au-dessus de ladite enclume (34), ainsi que d'une pièce à travailler placée sur ladite enclume (34), le chemin d'application d'énergie (108) s'étendant transversalement d'un côté à l'autre de la surface de travail externe (32), ledit système énergétique comprenant en outre un moyen d'application simultanée de pression et d'énergie thermique à la pièce à travailler, via ladite corne (70), sur ladite enclume (34), de manière à accomplir le travail sur la pièce à travailler alors que ladite corne (70) parcourt ainsi le chemin d'application d'énergie (108).

11. Système énergétique selon la revendication 10, dans lequel ladite corne (70) comprend une roue montée rotative autour d'un second axe (110), pour ainsi appliquer à la pièce à travailler une énergie thermique en un point (112) se déplaçant progressivement d'un côté à l'autre de la pièce à travailler tandis que ladite corne (70) parcourt ledit chemin d'application d'énergie (108).

12. Système énergétique selon l'une au moins des revendications 10 ou 11, dans lequel ladite corne (70) consiste en une corne rotative, de préférence une sonotrode rotative, ledit chemin d'application d'énergie (108) comprenant un segment sortant dans lequel ladite corne rotative (70) s'étend au-dessus de ladite enclume (34) et un segment entrant dans lequel ladite corne rotative (70) est retirée de dessus ladite enclume (34), ledit système énergétique comprenant en outre (a) un moyen (76) d'application de pression à la pièce à travailler, via ladite corne rotative (70), tandis que ladite corne (70) parcourt ledit chemin d'application d'énergie (108), et (b) un moyen de commande (78) conçu pour activer ledit moyen (76) d'application de pression, pour ainsi appliquer à la pièce à travailler une pression, via ladite corne rotative (70), sur l'un desdits segments dudit chemin d'application d'énergie (108) et pour retenir la pression sur l'autre desdits segments dudit chemin d'application d'énergie (108).

13. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ledit système énergétique comprend au moins deux desdites enclumes (34) montées en des emplacements radiaux différents autour de ladite surface de travail externe (32) dudit tambour (26) et, de manière correspondante, au moins deux desdites cornes rotatives, de préférence des sonotrodes rotatives, montées de manière à tourner avec ledit tambour (26) et au-dessus respectivement de chacune desdites au moins deux enclumes (34), ledit système énergétique comprenant en outre un moyen de commande incluant des moyens (54, 56, 58, 60, 62) pour commander le fonctionnement de l'ensemble desdites au moins deux cornes rotatives (70) de sorte que chaque corne rotative (70) respective commence par s'étendre au-dessus d'une enclume respective (34) lorsque ladite enclume respective (34) est disposée en un emplacement correspondant à un premier angle "E" mesuré par rapport à la ligne de référence passant par ledit premier axe (28) de rotation et se retirant ensuite de dessus ladite enclume respective (34), de sorte que ladite corne rotative (70) soit complètement retirée lorsque ledit tambour (26) a tourné au point que ladite enclume respective (34) soit disposée en un emplacement correspondant à un second angle "W" mesuré par rapport à la ligne de référence passant par ledit premier axe de rotation, les mêmes angles "E" et "W" s'appliquant pour chacune desdites au moins deux cornes (70).

14. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite corne consiste en une corne à surface plane de type plongeur (170), de préférence une sonotrode à surface plane de type plongeur, ayant une surface de travail (32), de préférence une surface de travail à ultrasons, montée essentiellement à fleur de ladite surface de travail externe (32) dudit tambour (26).

15. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite enclume (134) est montée de manière à pouvoir s'étendre au-dessus de ladite corne (170), et à pouvoir se retirer ensuite de dessus ladite corne (170) pendant chaque rotation dudit tambour (26).

16. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite enclume (134) est montée de manière à pouvoir s'étendre au-dessus de ladite corne (170), pour appliquer une pression à une pièce à travailler placée sur ladite corne (170), et ainsi appliquer à la pièce à travailler une énergie thermique, de préférence une énergie par ultrasons, alors que ladite enclume est étendue au-dessus de ladite corne (170).

17. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite enclume (134) est montée de manière à parcourir un chemin d'application d'énergie (108) au-dessus de ladite corne (170) et d'une pièce à travailler placée sur ladite corne (170), et pour appliquer à la pièce à travailler, placée sur ladite corne (170), simultanément une pression et une énergie thermique, accomplissant ainsi le travail sur la pièce à travailler, alors qu'elle parcourt ladite corne (170).

18. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite enclume (134) comprend une roue montée rotative autour d'un second axe (110), de sorte que la combinaison de ladite enclume (134) et de ladite corne (170) fournisse une énergie thermique efficace, de préférence une énergie par ultrasons, à la pièce à travailler en un point se déplaçant progressivement d'un côté à l'autre de la pièce à travailler tandis que ladite enclume (134) parcourt ledit chemin d'application d'énergie (108).

19. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite enclume (134) consiste en une enclume rotative (134), ledit chemin d'application d'énergie (108) comprenant un segment sortant dans lequel ladite enclume rotative (134) s'étend au-dessus de ladite corne (170), et un segment entrant dans lequel ladite enclume (134) est retirée de dessus ladite corne (170), ledit système énergétique comprenant en outre (a) un moyen (76) pour appliquer à la pièce à travailler une pression via ladite enclume rotative (134) tandis que l'enclume (134) parcourt ledit chemin d'application d'énergie (108), et (b) un moyen de commande (78) conçu pour activer ledit moyen (76) d'application de pression, pour ainsi appliquer à la pièce à travailler une pression via ladite enclume rotative (134) sur l'un desdits segments dudit chemin d'application d'énergie (108) et pour retenir la pression descendante sur l'autre desdits segments dudit chemin d'application d'énergie (108).

20. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ladite enclume (134) consiste en une enclume rotative (134), ledit chemin d'application d'énergie (108) comprenant un segment sortant dans lequel ladite enclume rotative (134) s'étend au-dessus de ladite corne (170) et un segment entrant dans lequel ladite enclume rotative (134) est retirée de dessus ladite corne, ledit système énergétique comprenant en outre (a) un moyen (76) pour appliquer à la pièce à travailler une pression descendante via ladite enclume rotative (134) tandis que l'enclume (134) parcourt ledit chemin d'application d'énergie (108), et (b) un moyen de commande (78) conçu pour activer ledit moyen (76) d'application de pression descendante, pour ainsi appliquer à la pièce à travailler une pression descendante via ladite enclume rotative (134) sur l'un desdits segments dudit chemin d'application d'énergie (108) et retenir la pression descendante sur l'autre desdits segments dudit chemin d'application d'énergie (108).

21. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ledit système énergétique comprend au moins deux desdites cornes (170) montées en des emplacements radiaux différents autour de ladite surface de travail (32) dudit tambour (26) et, de manière correspondante, au moins deux desdites enclumes rotatives (134) montées de manière à tourner avec ledit tambour (26) respectivement au-dessus de l'une desdites au moins deux cornes (170), ledit système énergétique comprenant en outre des moyens de commande (54, 56, 58, 60, 62) du fonctionnement de l'ensemble desdites au moins deux enclumes rotatives (134) de sorte que chaque enclume respective (134) commence à s'étendre au-dessus de chaque corne respective (170) lorsque ladite enclume respective (134) est disposée en un emplacement correspondant à un premier angle "E" mesuré par rapport à une ligne de référence passant par ledit premier axe (28) de rotation et se retire ensuite de dessus l'enclume respective (134) de sorte que ladite corne rotative (170) soit complètement retirée de dessus ladite corne respective lorsque ledit tambour (26) a tourné au point que ladite corne respective (170) soit disposée selon un second angle "W" mesuré par rapport à la ligne de référence passant par ledit premier axe (28) de rotation, les mêmes angles "E" et "W" s'appliquant pour chacune desdites au moins deux cornes (170).

22. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ledit système énergétique comprend en outre un moyen de mise en place (92) adjacent audit tambour (26), formant une station de mise en place disposée selon un angle "P" mesuré par rapport à la ligne de référence qui passe par ledit premier axe (28), pour placer une pièce à travailler sur une station de travail (106) de ladite surface de travail externe (32) où l'énergie thermique, de préférence l'énergie par ul-

trasons, peut être appliquée à la pièce à travailler par lesdits premier et second dispositifs d'application d'ultrasons (34, 70 ; 134, 170) ; un moyen d'enlèvement (96) adjacent audit tambour (26), au niveau d'une station d'enlèvement disposée selon un angle "R" mesuré par rapport à la ligne de référence passant par ledit premier axe (28), pour enlever la pièce à travailler de ladite surface de travail externe (32) de sorte que la pièce à travailler parcourt un chemin de travail (114) sur ladite surface de travail externe (32) autour de la circonférence dudit tambour (26) depuis ladite station de mise en place jusqu'à ladite station d'enlèvement ; et un moyen de commande du mouvement dudit second dispositif d'application d'énergie (70 ; 134) de sorte que ledit second dispositif d'application d'énergie (70 ; 134) s'étende au-dessus dudit tambour (26) et, de façon correspondante, au-dessus dudit premier dispositif d'application d'énergie (34 ; 170) ainsi que de la pièce à travailler, tandis que la pièce à travailler parcourt ledit chemin de travail (114) et se retire de dessus ledit tambour (26) et dudit premier dispositif d'application d'énergie (34 ; 170) pendant que ladite station de travail (106) de ladite surface de travail externe (32) va de ladite station d'enlèvement vers ladite station de mise en place.

23. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ledit système énergétique comprend en outre un moyen de mise en place (92) adjacent audit tambour (26), au niveau d'une station de mise en place disposée selon un angle "P" mesuré par rapport à une ligne de référence qui passe par ledit premier axe (28), pour placer une pièce à travailler sur une station de travail (106) de ladite surface de travail externe (32) où l'énergie thermique peut être appliquée à la pièce à travailler par lesdits premier et second dispositifs d'application d'énergie (34, 70 ; 134, 170) ; un moyen d'enlèvement (96) adjacent audit tambour (26), formant une station d'enlèvement disposée selon un angle "R" mesuré par rapport à la ligne de référence qui passe par ledit premier axe (28), pour enlever la pièce à travailler de ladite surface de travail externe (32), de sorte que la pièce à travailler parcourt un chemin de travail (114) sur ladite surface de travail externe (32) autour de la circonférence dudit tambour (26) depuis ladite station de mise en place jusqu'à ladite station d'enlèvement ; et un moyen de commande du mouvement de ladite corne, de préférence desdites au moins deux cornes, mieux de ladite corne rotative, de sorte que ladite corne (70) s'étende au-dessus dudit tambour (26) et, de manière correspondante, au-dessus de ladite enclume (34) ou enclumes ainsi que de la pièce à travailler, tandis que la pièce à travailler parcourt ledit chemin de travail (114), et se retire de dessus ledit tambour (26) et de ladite enclume (34) ou enclumes alors que ladite station de travail (106) de ladite surface de travail externe (32) va de ladite station d'enlèvement à ladite station de mise en place.

24. Système énergétique selon l'une au moins des revendications précédentes, dans lequel ledit système énergétique comprend en outre un moyen de mise en place (92) adjacent audit tambour (26), formant une station de mise en place disposée selon un angle "P" mesuré par rapport à une ligne de référence qui passe par ledit premier axe (28), pour placer une pièce à travailler sur une station de travail (106) de ladite surface de travail externe (32) où une énergie thermique peut être appliquée à la pièce à travailler par lesdits premier et second dispositifs d'application d'ultrasons (34, 70 ; 134, 170) ; un moyen de mise en place adjacent audit tambour (26), au niveau d'une station d'enlèvement disposée selon un angle "R" mesuré par rapport à la ligne de référence qui passe par ledit premier axe (28), pour enlever la pièce à travailler de ladite surface de travail externe (32), de sorte que la pièce à travailler parcourt un chemin de travail (114) sur ladite surface de travail externe (32) autour de la circonférence dudit tambour (26) depuis ladite station de mise en place jusqu'à ladite station d'enlèvement ; et un moyen de commande du mouvement de ladite enclume (134) de sorte que ladite enclume (134) s'étende au-dessus dudit tambour (26) et, de manière correspondante, au-dessus de ladite corne (170) ainsi que de la pièce à travailler tandis que la pièce à travailler parcourt ledit chemin de travail (114) et est retirée de dessus ledit tambour (26) et de ladite corne (170) tandis que ladite station de traitement (106) de ladite surface de travail externe (32) va de ladite station d'enlèvement à ladite station de mise en place.

25. Système énergétique selon la revendication 24, dans lequel ledit moyen de commande commande le mouvement d'au moins deux enclumes (134) de sorte que lesdites au moins deux enclumes (134) s'étendent au-dessus dudit tambour (26) et, de manière correspondante, au-dessus desdites cornes (170) et de la pièce à travailler tandis que la pièce à travailler parcourt ledit chemin de travail (114), et sont retirées de dessus ledit tambour (26) et lesdites cornes (170) tandis que ladite station de travail (106) de ladite surface de travail externe (32) va de la station d'enlèvement à ladite station de mise en place.

26. Procédé pour appliquer à une pièce à travailler une énergie thermique, ledit procédé comprenant les étapes consistant :

a) à faire tourner un tambour autour d'un pre-

mier axe dans une direction donnée, le tambour présentant une surface de travail circonférencielle externe, un premier dispositif d'application d'énergie monté sur le tambour au niveau de ladite surface de travail externe et s'étendant transversalement à la direction de rotation du tambour ;
b) à prévoir un second dispositif d'application d'énergie, monté de manière à tourner avec le tambour ;
c) à déplacer le second dispositif d'application d'énergie dans une direction transversale à la direction de rotation du tambour et ainsi à étendre le second dispositif d'application d'énergie au-dessus du premier dispositif d'application d'énergie et à faire fonctionner les premier et second dispositifs d'application d'énergie en combinaison, appliquant ainsi une énergie thermique à la pièce à travailler en un point se déplaçant progressivement d'un côté à l'autre de la pièce à travailler pendant la rotation du tambour; et
d) à disposer le second dispositif d'application d'énergie à l'écart du tambour, enlevant ainsi le second dispositif d'application d'énergie de dessus le premier dispositif d'application d'énergie pendant la rotation du tambour,

l'un des premier et second dispositifs d'application d'énergie consistant en une corne conçue pour fournir une énergie thermique, l'autre des dispositifs d'application d'énergie consistant en une enclume conçue pour coopérer avec la corne.

27. Procédé selon la revendication 26, dans lequel au moins l'un desdits dispositifs énergétiques est un dispositif d'application d'ultrasons, de préférence une sonotrode.

28. Procédé selon l'une des revendication 26 ou 27, dans lequel ladite énergie thermique est produite par résistance électrique et/ou par ultrasons et/ou par induction électrique et/ou par fluide calorifique.

29. Procédé selon l'une au moins des revendications 26 à 28, comprenant une étape d'application d'énergie thermique à ladite pièce à travailler via ledit second dispositif d'application d'énergie.

30. Procédé selon l'une au moins des revendications 26 à 29, comprenant une étape d'extension du second dispositif d'application d'énergie au-dessus du premier dispositif d'application d'énergie, puis d'enlèvement du second dispositif d'application d'énergie de dessus le premier dispositif d'application d'énergie, pendant chaque rotation du tambour.

31. Procédé selon l'une au moins des revendications 26 à 30, comprenant une étape d'extension du second dispositif d'application d'énergie au-dessus du premier dispositif d'application d'énergie, et d'application d'une pression sur une pièce à travailler placée sur le premier dispositif d'application d'énergie, et ainsi d'application d'une énergie thermique à la pièce à travailler.

32. Procédé selon l'une au moins des revendications 26 à 31, comprenant une étape de parcours par le second dispositif d'application d'énergie d'un chemin d'application d'énergie au-dessus du premier dispositif d'application d'énergie et d'une pièce à travailler placée sur le premier dispositif d'application d'énergie, et d'application simultanée de pression et d'énergie thermique sur la pièce à travailler placée sur le premier dispositif d'application d'énergie, et ainsi d'accomplissement du travail sur la pièce à travailler tandis qu'elle parcourt le chemin d'application d'énergie.

33. Procédé selon la revendication 32, dans lequel le premier dispositif d'application d'énergie consiste en une enclume, le second dispositif d'application d'énergie consiste en une sonotrode rotative comprenant une roue montée rotative autour d'un second axe, ledit procédé comprenant une étape d'application d'énergie thermique à une pièce à travailler en un point se déplaçant progressivement d'un côté à l'autre de la pièce à travailler tandis que le second dispositif d'application d'énergie parcourt le chemin d'application d'énergie.

34. Procédé selon l'une au moins des revendications 32 à 33, comprenant une étape d'application de pression à la pièce à travailler, via le second dispositif d'application d'énergie, tandis que le second dispositif d'application d'énergie parcourt le chemin d'application d'énergie.

35. Procédé selon l'une au moins des revendications 32 à 34, dans lequel le chemin d'application d'énergie comprend un segment sortant dans lequel se produit l'extension du second dispositif d'application d'énergie au-dessus du premier dispositif d'application d'énergie et un segment entrant dans lequel se produit le retrait du second dispositif d'application d'énergie de dessus le premier dispositif d'application d'énergie, le procédé comprenant en outre une étape de commande du second dispositif d'application d'énergie et ainsi d'application de pression à la pièce à travailler, via le second dispositif d'application d'énergie, sur l'un des segments du chemin d'application d'énergie et de retenue de la pression sur l'autre des segments du chemin d'application d'énergie.

36. Procédé selon l'une au moins des revendications

32 à 35, dans lequel le chemin d'application d'énergie comprend un segment sortant dans lequel se produit l'extension de la sonotrode rotative au-dessus d'une enclume et un segment entrant dans lequel se produit le retrait de la sonotrode rotative de dessus l'enclume, ledit procédé comprenant en outre une étape de commande de la sonotrode rotative et ainsi d'application d'une pression à la pièce à travailler, via la sonotrode rotative, sur l'un des segments du chemin d'application d'énergie et de retenue de la pression sur l'autre des segments du chemin d'application d'énergie.

37. Procédé d'application d'énergie thermique à une pièce à travailler, spécialement selon au moins l'une des revendications 26 à 36 utilisant un système énergétique selon au moins l'une des revendications 1 à 25.

38. Procédé selon la revendication 37, dans lequel ledit système énergétique, de préférence un système à ultrasons, comprend au moins deux premiers dispositifs d'application d'énergie montés en des emplacements radiaux différents autour de la surface de travail externe du tambour, et au moins deux seconds dispositifs d'application d'énergie correspondants montés de manière à tourner avec le tambour et au-dessus respectivement, de chacun des au moins deux premiers dispositifs d'application d'énergie, et comprenant la commande du fonctionnement de l'ensemble des au moins deux seconds dispositifs d'application d'énergie et ainsi le commencement de l'extension de chaque second dispositif d'application d'énergie au-dessus d'un premier dispositif d'application d'énergie respectif lorsque le premier dispositif d'application d'énergie respectif est disposé en un emplacement correspondant à un premier angle "E" mesuré par rapport à une ligne de référence qui passe par le premier axe de rotation, la rotation du tambour, puis le commencement du retrait du second dispositif d'application d'énergie respectif de dessus le premier dispositif d'application d'énergie respectif de sorte que le second dispositif d'application d'énergie soit complètement retiré de dessus le premier dispositif d'application d'énergie respectif lorsque le tambour a tourné au point que le premier dispositif d'application d'énergie soit disposé selon un second angle "W" mesuré par rapport à la ligne de référence qui passe par le premier axe de rotation, les mêmes angles "E" et "W" mesurés par rapport à la ligne de référence passant par le premier axe de rotation s'appliquant à chacun desdits au moins deux dispositifs d'application d'énergie.

39. Procédé selon l'une au moins des revendications 26 à 38, comprenant la mise en place d'une pièce à travailler sur une station de travail de la surface de travail externe selon un angle "P" mesuré par rapport à une ligne de référence qui passe par le premier axe ; la rotation du tambour ; tandis que le tambour tourne, la commande du mouvement du second dispositif d'application d'énergie et, ainsi, l'extension du second dispositif d'application d'énergie au-dessus du tambour et, de manière correspondante, au-dessus de la pièce à travailler ; et le retrait du second dispositif d'application d'énergie de dessus le tambour de sorte que le second dispositif d'application d'énergie soit retiré de dessus le tambour tandis que la station de travail de la surface externe de travail va de la station d'enlèvement à la station de mise en place.

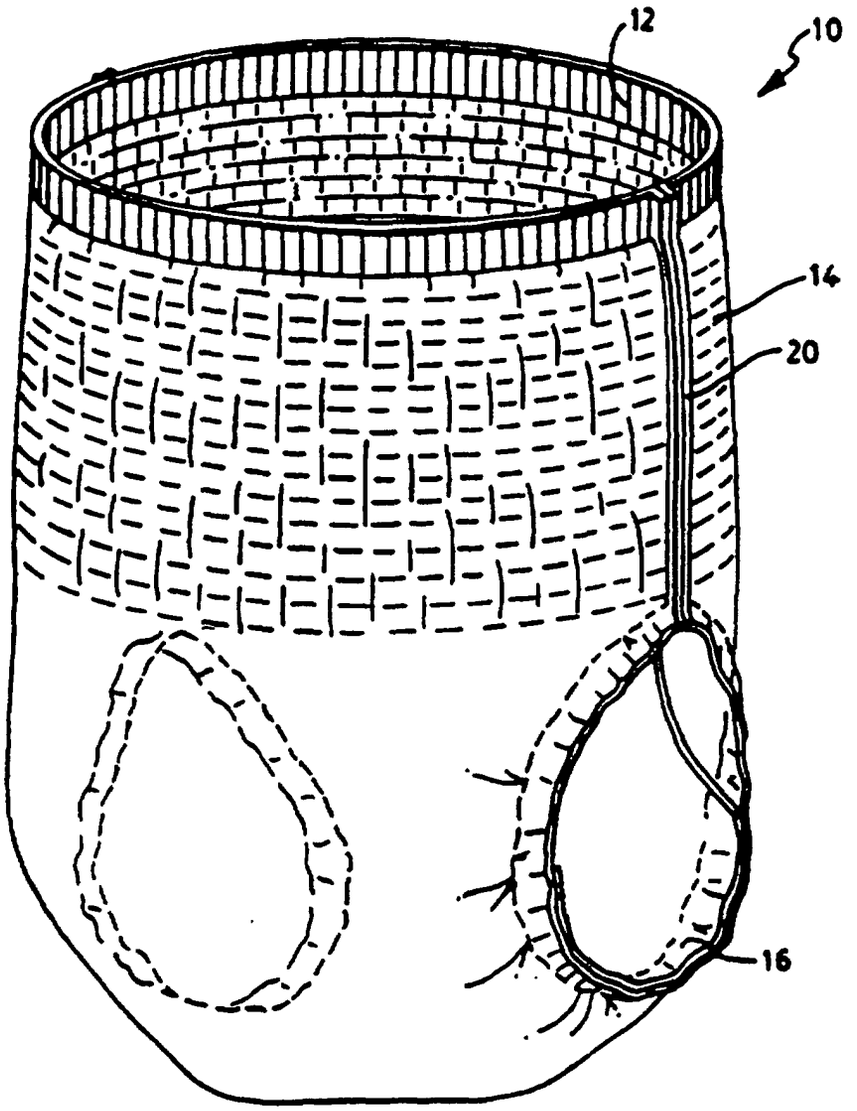


FIG. 1

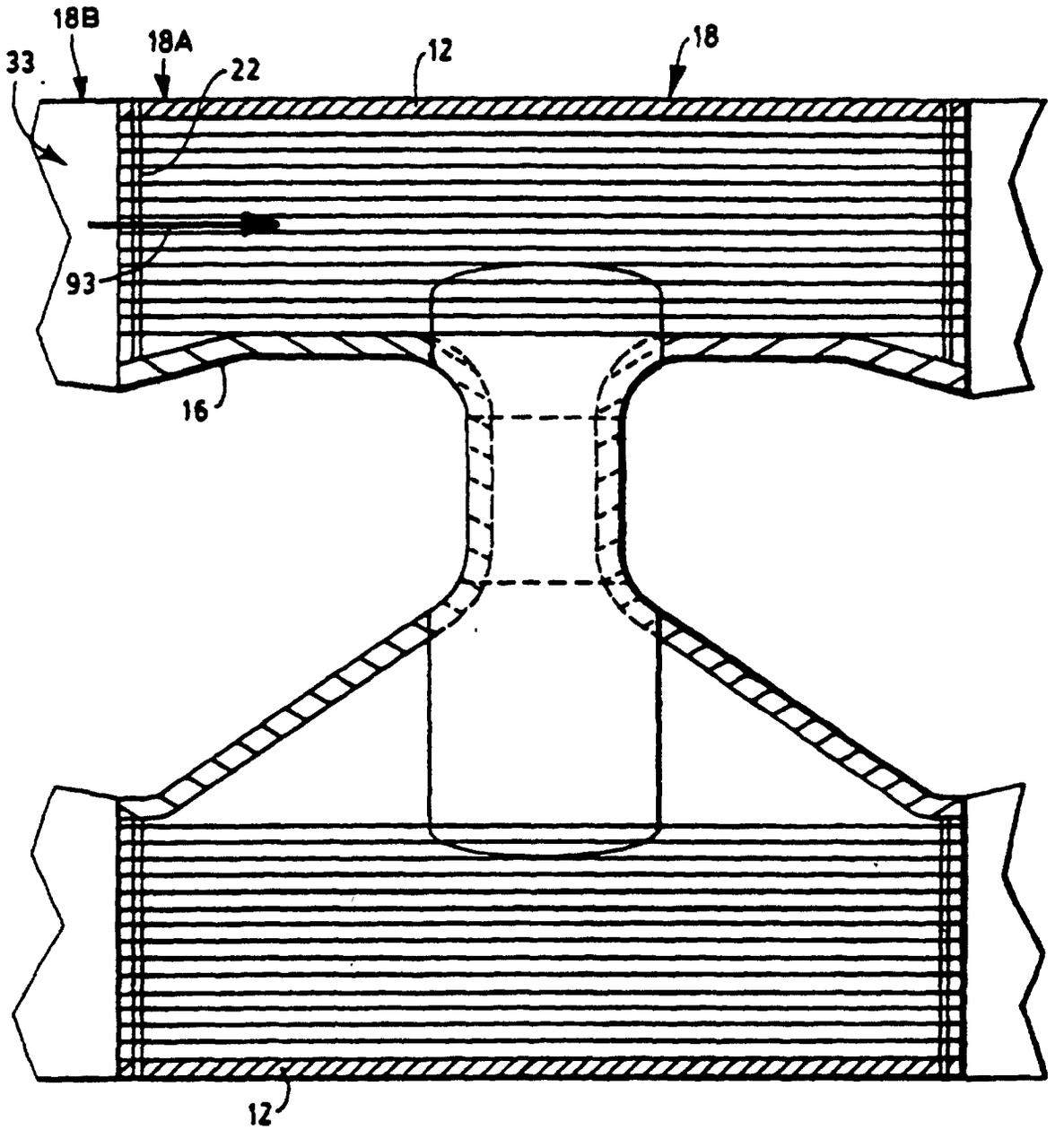
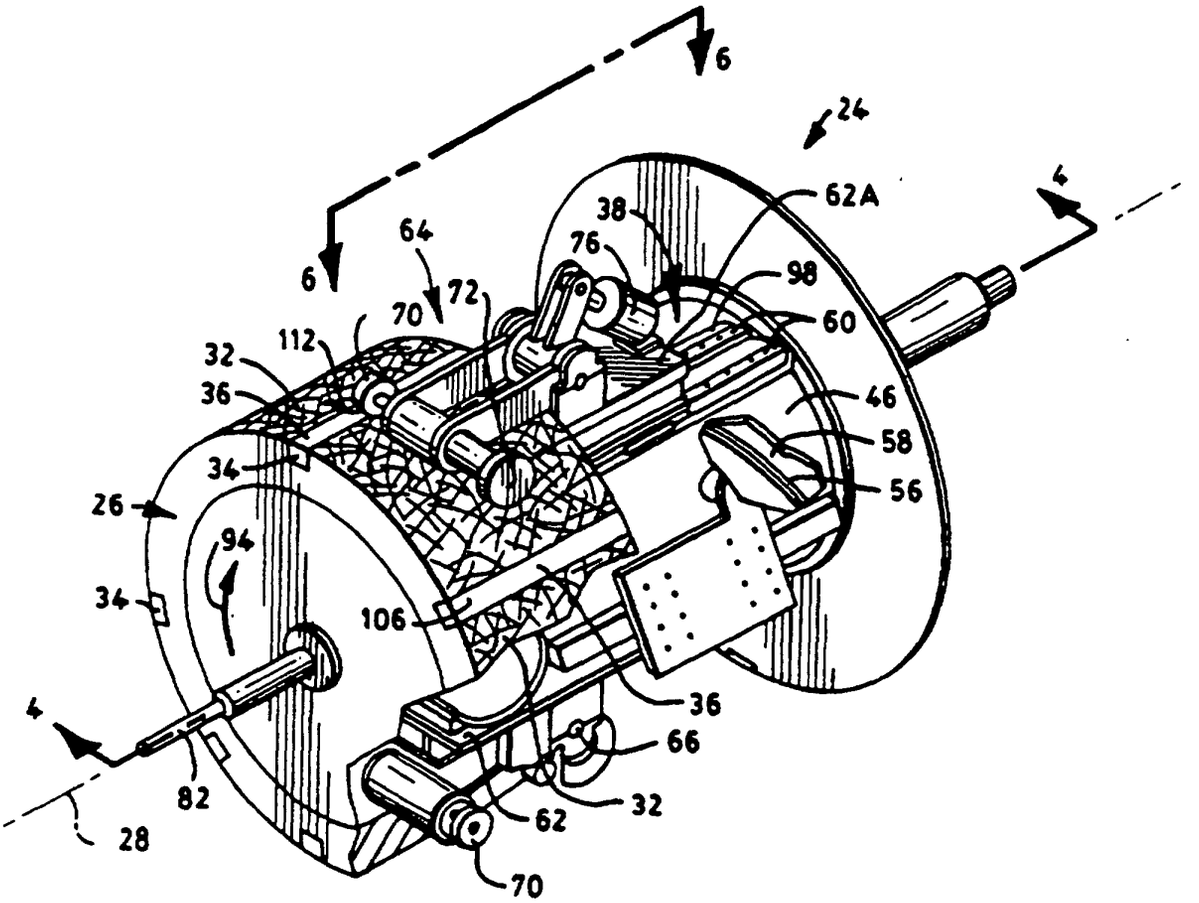


FIG. 2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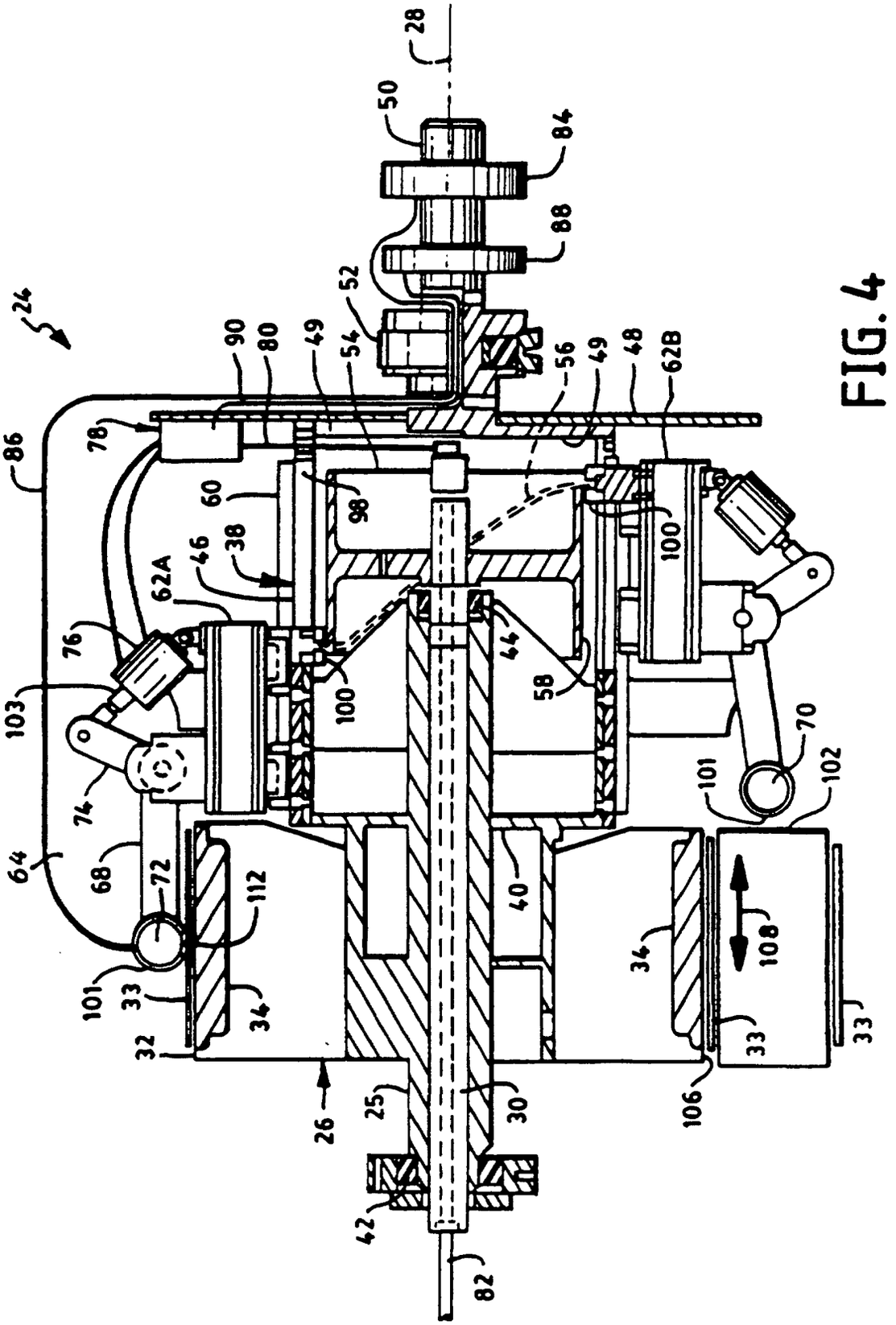
70

FIG. 3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52
24
90
80
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54
56
49
48
62B
86
78
60
98
100
38
46
62A
76
44
58
103
74
70
101
102
64
68
72
112
40
34
108
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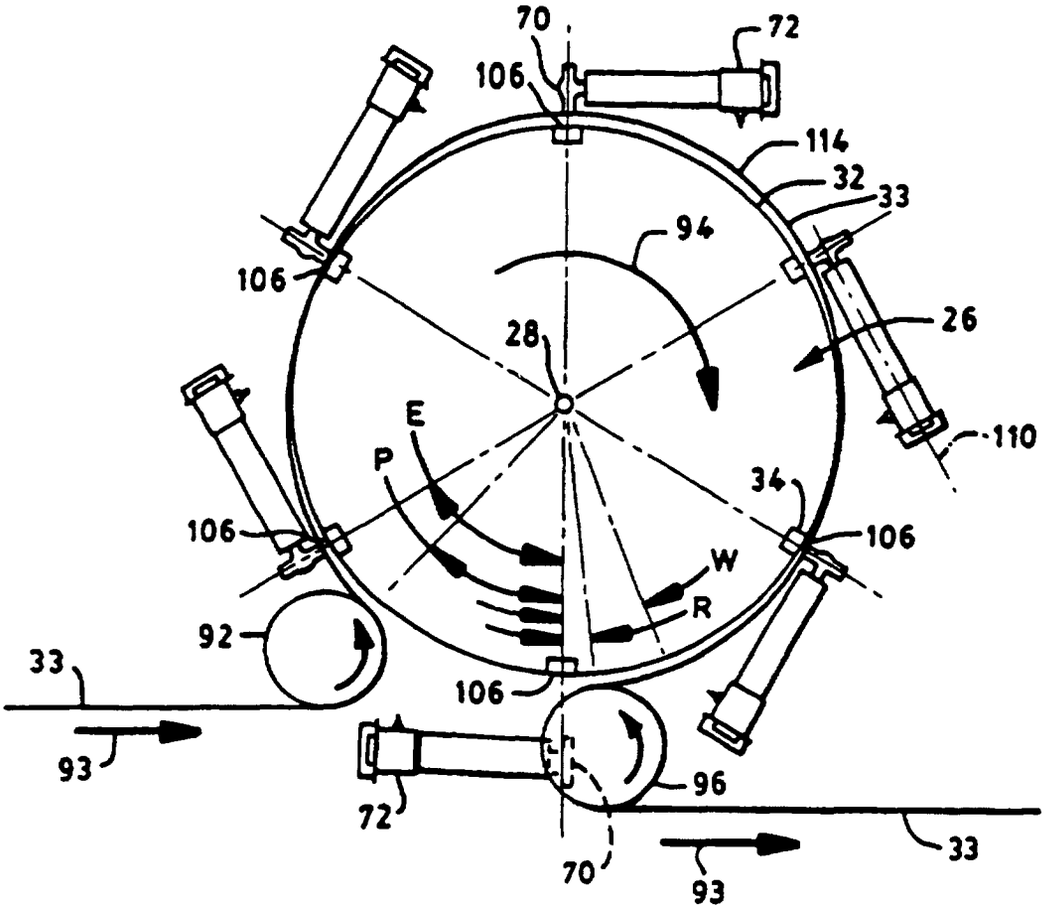
33
34
33
33
32
26
25
30
106
42
82

FIG. 4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33
94
106
26
28
110
E
P
34
106
106
W
R
92
33
106
93
96
72
33
70
93

FIG. 5

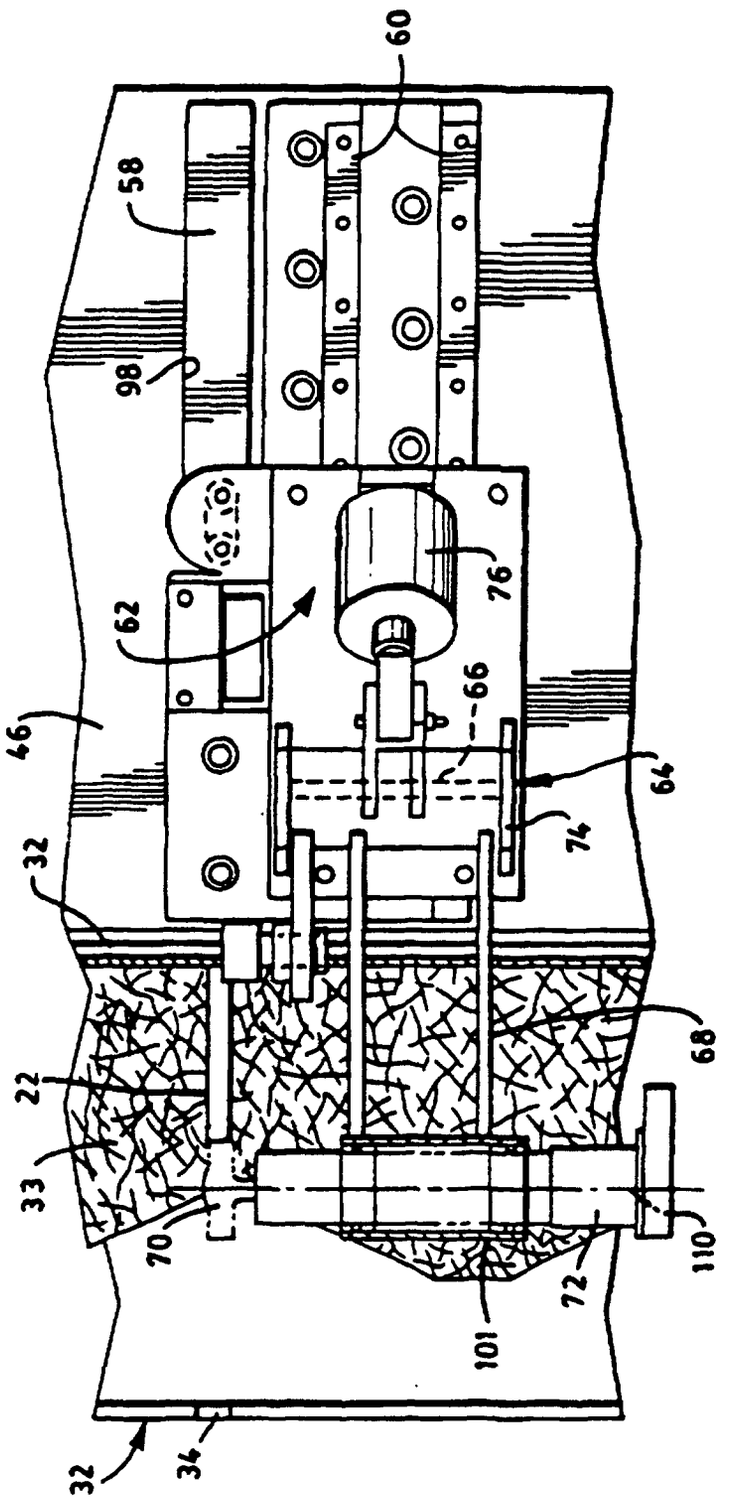

FIG. 6

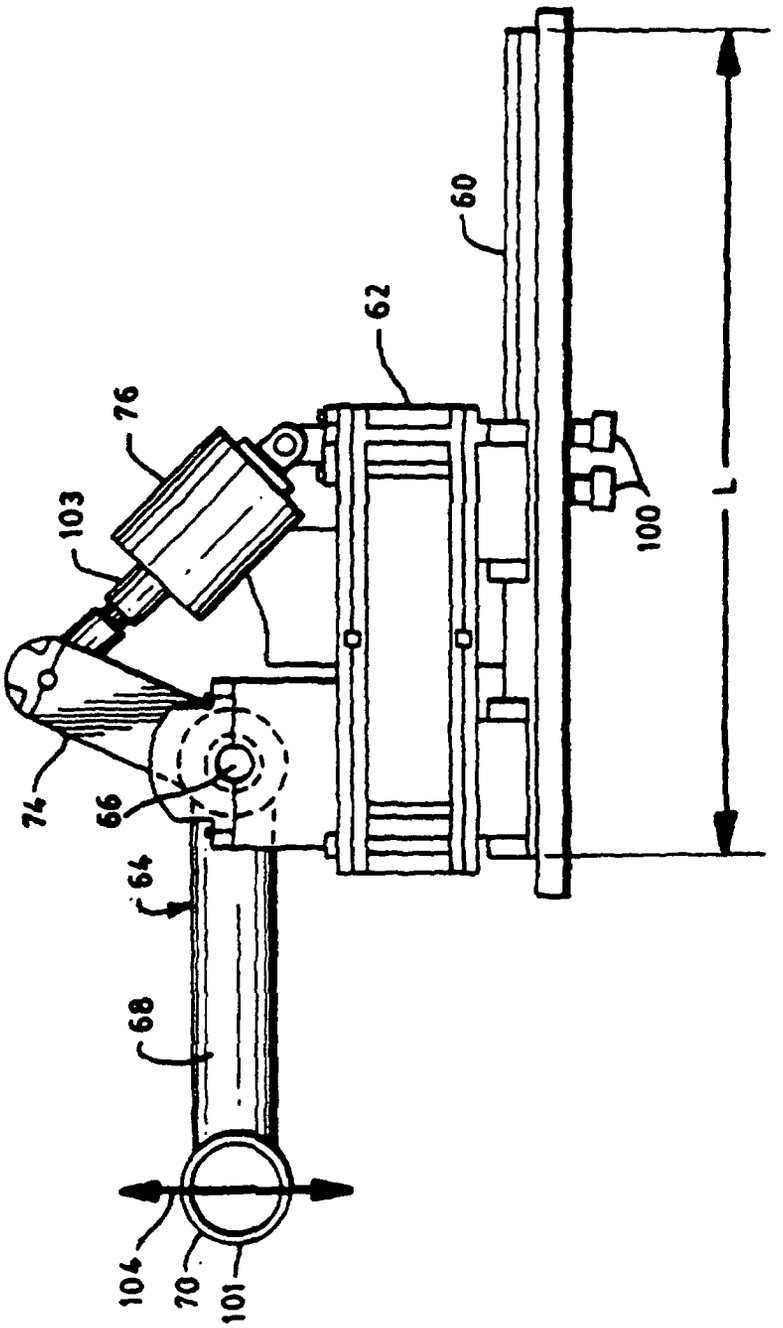

FIG. 7

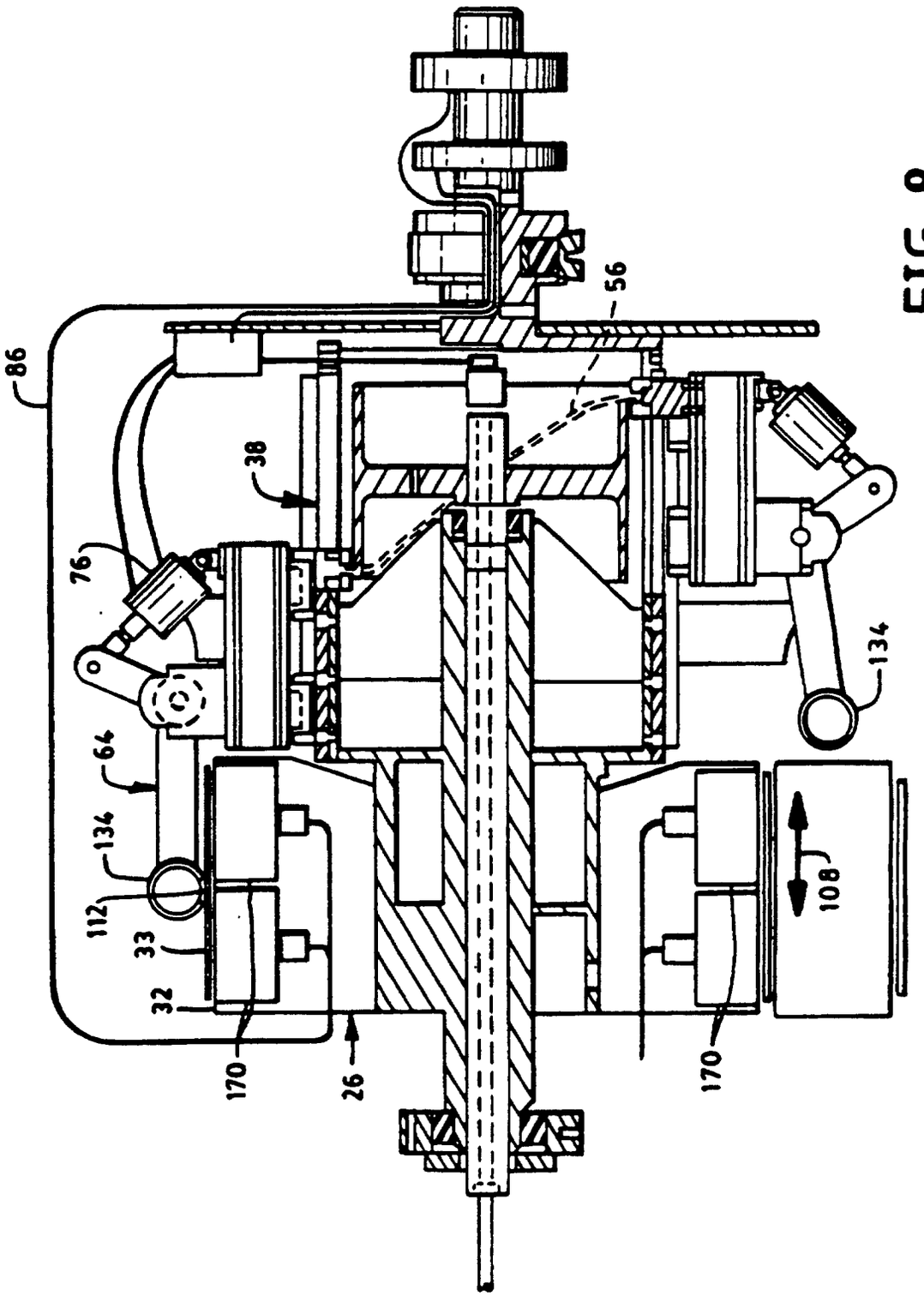

FIG. 8